

**EFFECTS OF CONSERVATION FARMING IN ZIMBABWE: THE CASE OF  
UMGUZA DISTRICT IN THE POST 2000 LAND REFORM PROGRAMME**

By

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Submitted in accordance with the requirements for the degree of

DOCTOR OF PHILOSOPHY

At the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF. VUSI GUMEDE

SEPTEMBER 2019

## DECLARATION

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Effects of conservation farming in Zimbabwe: The case of Umguza District in the post 2000 land reform programme

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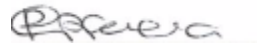
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## **DEDICATION**

This study is dedicated to my family.

## **ACKNOWLEDGEMENTS**

I would like to express my gratitude to my family, friends and colleagues for contributing immeasurably to this work through their continuous support. Deserving special mention is my supervisor Professor Gumede who contributed to this work through his constructive criticism chapter by chapter. Thank you for your concern, time, advice and commitment towards this work. I would also like to appreciate the smallholder farmers and the extension officers who were a great resource to this research through providing their valuable time and information for this work. To my mother, Mrs Lucy Chipfakacha, thank you for the continuous encouragement to work hard and not give up on my dreams. Lastly, I would like to thank Mandla Siziba for taking his time to go through the thesis and provide his expertise on language editing; I truly appreciate this.

## ABSTRACT

The study analysed the effects of conservation farming in Zimbabwe using a mixed methodology approach. This analysis comes against the background of the recognition that climate change, as characterized by severe droughts, has played a significant role in reducing agricultural productivity, in the process leaving smallholder farmers and the nation of Zimbabwe exposed to recurrent food insecurity. Conservation farming was introduced as a climate adaptation strategy that was aimed at improving crop yields. The study focused on assessing the association between the adoption of conservation farming and a concomitant increase in agricultural productivity. This was key in understanding if there are benefits of using conservation farming as opposed to making use of the conventional method of farming. The study also investigated the nature of conservation farming being practiced in Umguza District; this was done in order to understand whether smallholder farmers are implementing all the key principles underpinning the use of conservation farming. The study further assessed the challenges and opportunities that exist through the use of conservation farming with the aim of coming up with sustainable solutions to the challenges affecting smallholder farmers. The study went on to assess the factors that determine the adoption and maximum utilization of conservation farming. Identification of these key variables was instrumental in the design of a localized conservation farming model. Study results revealed that conservation farming is an effective method of increasing agricultural productivity. The study also established that smallholder farmers are not implementing all the key principles of conservation farming and this was attributed to the failure to include the smallholder farmers in the design of conservation farming models. It was further revealed that smallholder farmers face various challenges that include access to inputs and limited support from the government. Implications of the study highlight the need for the community to be actively involved in the design of a conservation farming model localized to the unique context of smallholder farmers. A prototype for implementing a sustainable conservation farming model was developed in collaboration with the smallholder farmers as part of a solution based approach to dealing with the challenges affecting smallholder farmers.

**Key words:** Conservation farming, smallholder farmers, agricultural productivity, climate change.

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## **LIST OF ACRONYMS**

AIDS	Acquired Immune Deficiency Syndrome
ARV	Antiretroviral
CIMMYT	Central International Maize and Wheat Centre
CF	Conservation Farming
DFID	Department for International Development
ECAF	European Conservation Agriculture Federation
GHI	Global Harvest Initiative
GOZ	Government of Zimbabwe
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
FAO	Food Agriculture Organisation
MDC	Movement for Democratic Change
NC3R	National Centre for the Replacement Refinement and Reduction of Animals in Research
NORAD	Norwegian Agency for Development Cooperation
PRD	Parliament Research Department

SIDA	Swedish International Development Agency
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	UN office for Disaster Risk Reduction
ZIMSTAT	Zimbabwe National Statistics Agency
ZIMVAC	Zimbabwe Vulnerability Assessment Committee

## **CHAPTER ONE**

### **INTRODUCTION**

The chapter outlines the background of the study by giving a synopsis of conservation farming in relation to the agricultural sector in Zimbabwe. An overview of the agricultural sector in Zimbabwe is presented, detailing the work that has been done in the implementation of conservation farming - albeit with problems - resulting in the need to conduct an assessment of the effects of conservation farming. The researcher articulates the problem informing the study as well as the importance of the research to the development discourse. The objectives and the key research questions guiding the study are explained. Clarification of important concepts is also given in a bid to explicate the important terms frequently used in the research. In assessing the effects of conservation farming in Zimbabwe, the study made a deliberate focus on the agricultural productivity of maize based on two main reasons. Firstly, maize is the staple food in Zimbabwe which means that it is the most popular crop that is consumed and grown in the country hence it has a bearing on the nation's food security needs (FAO, 2012). Secondly, the government of Zimbabwe is spending a considerable chunk of foreign currency on the importation of maize yet it is faced with a major foreign currency crisis. GOZ (2018) confirms that in pursuit of meeting the food security needs of the nation of Zimbabwe, the government annually imports an average of 900 000 tons of maize. This is done to serve the nationwide needs of 1.8 million tons of maize to warrant food security for the nation. Based on these reasons, the research made an intentional focus on the agricultural productivity of maize. The primary aims of the post 2000 land reform programme are also discussed relative to their impact on agricultural productivity.

#### **1.1 Background of the study**

According to Nkala (2014), the adoption of conservation farming arose because of the need to improve agricultural productivity and ultimately the livelihoods of smallholder farmers upon the realisation that agricultural productivity had declined as a result of the significant changes in the

average weather patterns. Slater and Jones (2000) advance that changes in the climate will have an adverse bearing on agriculture towards the end of the 21<sup>st</sup> century which will thus diminish the hopes of poverty eradication in developing countries; hence the necessity to adopt conservation farming as a strategy to improve agricultural productivity (Nkala, 2014). The use of conservation farming is grounded on three key elements that include crop rotations, minimum soil tillage and soil cover (Mushango, 2017). The practise of this farming approach has been received with mixed feelings, with advocates for the use of conservation farming taking a stand in explaining the benefits of conservation farming in improving crop yield at a time when the nation of Zimbabwe and the world at large is affected by climate change and variability, resulting in food insecurity affecting smallholder farmers and communities (Mazimavi, 2011). The benefits associated with the use of conservation farming include a reduction in soil erosion; an improvement of the soil structure and increased opportunities for water harvesting that enables crops to survive in stressful environments associated with dry conditions and unreliable rainfall patterns (Haggblade and Tembo, 2003). Despite the advantages outlined in relation to the practice of conservation farming, smallholder farmers are still immensely challenged by the oddities of climate change resulting in low agricultural productivity (Nkala, 2014). The implication is that conservation farming has not delivered on its promises of ensuring food security for smallholder farmers and communities. It should also be noted that the practice of conservation farming has also been marred with resistance from smallholder farmers and as such this is also perceived as a factor resulting in the low yields being experienced by smallholder farmers (Mazimavi, 2011).

According to GHI (2018) the concern globally is whether the world is in a position to provide food to an expanding populace of an expected 10 billion people by 2050. GHI (2018) further explains in its global agricultural report that between the years 2013 and 2018 there has been slow agricultural growth that is not moving at a pace required by the demands of an expanding population. An analysis of the global total factor productivity which is an indicator for measuring agricultural productivity outlines that agricultural productivity has been growing by an average 1.51% against an expected 1.75%, the required rate annually to grow agricultural productivity to a point where it can feed the growing population by the year 2050 (GHI, 2018). A further analysis of the global total factor production anticipates that if the slow growth in agricultural productivity

continues, smallholder farmers in developing countries that include Zimbabwe, where the global total factor productivity is standing very low at 0.96%, will need to incur more expenses in terms of the inputs needed to increase their output yield harvested (GHI 2018). According to Mkonda and He (2017), with the current challenges affecting developing countries as a result of climate change and variability, there is an alarm for smallholder farmers to maximise on the use of climate smart approaches such as conservation farming to increase agricultural productivity which is key in improving the livelihoods of communities as well as promoting the development of these nations as they strive to transition from low income countries to upper middle income countries.

The post 2000 land reform programme was implemented in Zimbabwe with an intention to alter the agrarian structure, resulting in 99 percent of the farmers now being smallholder farmers (Zikhali, 2015). Under the pretext of redistributing the land in order to address the the previous racist apportionment practices, Zimbabwe's land reform has been met with mixed feelings with a number of bystanders alluding to it as a failed policy that stripped Zimbabwe the title of being an economic guru under the prestigious label "bread basket of Africa" to being a "begging basket of Africa" (Baldauf, 2008:26). A full-scale appraisal of the land reform programme, however, presents a dreary picture of a new phenomenon called climate change that has demonized the lucrative programme, hence resulting in the implementation of conservation farming as a climate smart mitigation approach (Gukurume, Dube and Nhodo, 2011).

Zimbabwe's land reform rhetoric debates have come a long way from the period of the advent of the white settlers, where the black population was dispossessed from the fertile and ancestral lands and pushed to less productive lands which were later to be called the Tribal Trust Lands using a policy instrument known as the Land Apportionment Act, (Moyana, 2002). This became the basis of the waging of the first and second liberation struggle. According to Kanyenze, Chitambara and Martins (2011), the colonial regime divided the country into freehold, state land and tribal trust lands. Upon the attainment of independence, it was projected that 70% of all arable land was controlled by a minority group of white commercial farmers (Chitsike, 2013). In the quest to address the century old colonial inequalities, the Zimbabwean government embarked on an accelerated fast track land resettlement programme in 2000, with the aim of decongesting the



communal lands and ultimately improving food security for the landless majority (Kanyenze et al., 2011).

The chief intentions of the fast track land reform programme included the rapid process of identifying more land to be distributed and allocated to the landless black people (Zikhali, 2015). The other ambition of the post 2000 land resettlement initiative was to speed up the sharing and distribution of land as well as to provide newly resettled farmers with support services that include basic infrastructure (Moyo, 2014). According to Zikhali (2015) the land reform programme focused on forcefully acquiring land which was principally owned by private companies and white commercial farmers. Kanyenze et al. (2011) argue that the land reform program was grounded on two approaches which included the A1 model which sought to ease crowding in communal areas and also empower farmers with adequate land. The focus of the A1 model was to help the poor acquire land for subsistence farming important for helping them meet their livelihood needs (Zikhali, 2008). The land reform programme was thus critical for empowering peasants to attain food security (Moyo, 2014).

Moyo (2014) explains that the A2 model was based on a scheme meant for commercial purposes. The A2 scheme had three groups that included large, average and small scale commercial farms which were aimed at empowering black farmers to go the commercial way (Sachikonye, 2013). Ideally, the A2 model was meant for any Zimbabwean national who could prove that they had experience in farming as well as the resources needed to run a commercially viable farm (Zikhali, 2008). Sachikonye (2013) claims the thrust of the land redistribution programme was to reduce poverty; however, it appears the worsening of poverty is one of the major outcomes of the land reform programme. This is because upon the implementation of the land redistribution exercise, Zimbabwe and other Sub- Southern African countries started experiencing an increase in erratic rainfall as from the year 2000 due to climatic changes (Kanyenze et al., 2011). Moyo (2014) argues that evaluating the land reform programme in separation from the politics of the day reveals grotesque levels of ignorance in assessing the conjoined twins, politics + economy = political economy. According to Logan (2006), analysts have been of the view that apart from the dry spells of nature, the land reform programme was ill planned and a political reaction to MDC's

mounting insistence on the government, thus in medicating itself from political headache the government took the land reform programme route as a pain killer. The poverty that Sachikonye (2013) sees as the outcome of the land redistribution in Zimbabwe is what Degeorges and Relly (2007) label as the politicization of land reform which has had adverse impacts on food production, use of wildlife, as well as conservation on both the national level and regional economies. In such circumstances, conservation farming seems to be based on shaky grounds since the foundation and background of the land reform is based on politics than on the intentions to set a tone of equality on resource allocation.

Upon realising how the natural environment in the form of climatic change was affecting the land reform programme, the government of Zimbabwe, through collaboration with non-governmental organisations, introduced conservation farming as a tactic to survive the negative effects of climate change that have stalled agricultural productivity in Umguza and other districts in the country (Nkala, 2014). Dube (2011) posits that it is noteworthy that natural pressures that include unpredictable weather patterns have a negative bearing on agriculture in Zimbabwe. The realisation of the shifting weather patterns propelled various government departments and organisations to introduce conservation farming as the remedy to the challenges that communal farmers were now facing (Sachs, 2008). The reasoning was to motivate smallholder farmers to diverge from using conventional agriculture to the use of conservation farming.

Twomlow, Urolov, Jenrich and Oldrieve (2008) observe that a task force with the obligation to promote conservation farming was established in 2003. This was a partnership that involved non-governmental organizations who sought to figure out the negative outcomes of climate change which were posing a threat to agricultural productivity and food security. Twomlow et al. (2008) posit that in 2004 the team devised a conservation farming approach that would be suited to the requirements of the various smallholder farmers. Thus conservation farming was conceived as an innovative alternative that could play a significant role in assisting poor farmers achieve agricultural productivity and food security despite the harsh climatic conditions (Nkala, 2014). Marongwe (2008) is of the view that despite the establishment of a task force aimed at spearheading the acquisition of all the technical and knowledge based skills, the role of the

government has been questioned by development partners. Marisa and Guaraldo (2015) note that the efforts to popularize conservation farming have solely been under the purview of external players that include the FAO and the German Technical Cooperation. Thus, this has made the government receive criticisms around the failure to have direct efforts towards addressing climate change and variability.

It is in this context that the study sought to establish whether conservation farming has been an effective method in augmenting agricultural productivity in Zimbabwe. This entailed the use of the natural experiment in assessing agricultural productivity amongst farmers practising conservation farming who naturally formed the treatment group and farmers practising the conventional method of farming who naturally formed the control group. The differences in the mean output harvest for smallholder farmers making use of conservation farming and those making use of the conventional method of farming guided the researcher to conclude that conservation farming is an effective method of increasing agricultural productivity as compared to the use of the conventional method of farming. The study also assessed the nature of the conservation farming approach being practised in Zimbabwe, particularly in Umguza District, and also explored the dynamics affecting the adoption of conservation farming as well as the challenges and benefits associated with the use of conservation farming.

## **1.2 The Agricultural Sector in Zimbabwe**

Dube (2015) outlines that the vision of the agricultural policy of Zimbabwe is to see an excelling and competitive agricultural sector that enables access to food and nutrition security for its citizens. This is a vision that is compelled by the recognition of the immense role that the agricultural sector has in contributing to the GDP of the country (Dube, 2015). According to the Comprehensive Agricultural Policy Framework of 2012-2032, the agricultural sector contributes between 15- 18% of the gross domestic product with over 70% of the rural citizens of Zimbabwe deriving their livelihoods from the agriculture sector (GOZ, 2018). The agricultural sector is dominated by an average of one million farmers who depend on rain fed agriculture with an estimated 70% of the

smallholder farmers utilizing an average of two hectares of land for their livelihoods (GOZ, 2018). Mashonjwa (2017) notes that the agricultural policy articulates that improving the standard of living in Zimbabwe and the expansion of the economy depend on the performance of the agriculture sector. Despite the notable role that the agricultural sector has to play in the development of the economy, Kayenze et al. (2011) argue that the post 2000 land reform programme marked a structural break in the performance of the Zimbabwean economy and in particular the agricultural sector. For instance, from being able to produce high quantities of maize, more than what was required, Zimbabwe is now struggling to meet the quantities of maize required for the nation, hence resorting to importing maize in view of the national requirements of having 1 800 000 tonnes of maize annually (GOZ, 2018). Mashonjwa (2017) posits that the challenges affecting the agricultural sector in Zimbabwe have been attributed to the impact of global warming on climate change. GOZ (2018) claims that it is against this background that yield reductions due to climate change have been set out at between 11% and 30% by the year 2030. Projections from the climate analysis predict that temperatures are set to increase by 25 degrees Celsius with rainfall declining by an average 4.1% by 2030 and 5.9% by the year 2070 (GOZ, 2018) - a clear indication that climatic changes still have a substantial part to play in terms of lowering crop productivity in Zimbabwe; hence the urgent need to address the effectiveness of conservation farming as a climate smart approach that is aimed at increasing crop yields (Mashonjwa, 2017).

Mashonjwa (2017) posits that there is no doubt that there is need to assess the effectiveness of climate smart approaches that have been implemented in Zimbabwe. This is because the 2015 and 2016 farming season triggered the need for Zimbabwe to develop resilient approaches to agriculture owing to the El- Nino drought that triggered the decline of agricultural productivity by five percent, leaving an average 2.8 million (21.5%) citizen's food insecure (Gukurume, 2016). It is critical to note that although climate change is having a negative effect on crop production, the agricultural sector is said to be the third largest contributor to greenhouse emissions in Zimbabwe (GOZ, 2018). According to GOZ (2018), conservation farming is classified as part of the three pillars of climate smart approaches that also include soil and water conservation as well as improved livestock management. The National Agricultural Policy Framework of 2018-2030, however, explains that despite the benefits of using conservation farming, the adoption of this

climate smart approach has been low as the use of conservation farming is estimated to have been adopted in 100 000 smallholder farms and on 125 000 hectares of land out of an estimated 1.3 million smallholder farms (GOZ, 2018). According to Gukurume (2016), those who have adopted the use of conservation farming have failed to produce significant yields to motivate other smallholder farmers to adopt the use of conservation farming with the hope of improving agricultural productivity.

According to Mashonjwa (2017), maize is the staple food in Zimbabwe and thus dominates in terms of production by smallholder farmers. Mazvimavi et al. (2010) argue that Zimbabweans on average consume three meals a day, constituting an average of 95 kilograms of maize annually, hence the reason why food security in Zimbabwe is related to access and availability of sufficient supplies of maize. However, despite the important role that maize plays as a staple food in Zimbabwe, its production in the country remains a critical challenge (Twomlow, 2014). It is against this background that it was critical to appraise the effects of conservation farming in Zimbabwe as an innovative approach to increasing agricultural productivity making reference to maize with an emphasis on understanding the factors that determine the adoption and full utilization of conservation farming. This was important because of the important role that conservation farming is supposed to play in dealing with the national and global need to double the crops that are produced per hectare (Mazimavi et al., 2010).

### **1.3 Conservation farming system in Zimbabwe**

According to Marongwe et al. (2015), conservation farming was first adopted in Zimbabwe in the late 1980s after being pioneered in plantations located in the northern areas of Zimbabwe. The implementation of conservation farming in Zimbabwe has been faced with the goliath task of having the need to transform farmer attitudes as it goes against their conventional beliefs (Rusinamhodzi, 2013). The predicament that many farmers have is how crops can be grown without tilling land (Berger and Friedrich, 2016). The adoption of conservation farming is not an event but a process that involves the complete overhaul of the farming system which entails

changing the way in which land is prepared and when, how and when weeds are controlled, crop rotations and the type of crops to be grown (Marongwe et al., 2015).

Conservation farming technology was adopted in Zimbabwe based on experiences from other countries where it was demonstrated to have been effective in improving agricultural productivity in Asia, America and different areas of Southern African countries that include Zambia and South Africa (Corbells et al., 2016). The idea behind the comprehensive introduction of conservation farming was scaled in the year 2003-2004 agricultural season with the aim of addressing the challenge of low yields and ultimately improve food security (Marongwe et al., 2015). The successful implementation and adoption of conservation farming in Zimbabwe's neighbouring country, Zambia, provided an enabling environment to facilitate the adoption of conservation farming in Zimbabwe (Nyathi, 2013). Mazvimavi and Twomlow (2009) argue that Zambia began to vigorously adopt the use of conservation farming in the early 1990s and this was steered by the Conservation Farming Unit. Bwalya (2015) agrees that conservation farming has done a great job in increasing crop productivity as evidenced by various research studies that were carried out in Zambia focusing on the effectiveness of conservation farming as a strategy of increasing crop productivity as well as improving food security. According to Bwalya and Friedrich (2016), Zambia's success story on the adoption and implementation of conservation farming propelled the transfer of training and support models to Zimbabwe from the year 2003 through various donor support programmes that have played an immense role in promoting the adoption of conservation farming.

Kassie and Zikhali (2009) argue that a task force was established in Zimbabwe that had an agenda of supporting smallholder farmers to adopt conservation farming. This is a taskforce that saw various non-governmental organizations collaborating with the government of Zimbabwe to promote the adoption of conservation farming (Nyathi, 2013). Musara et al. (2010) argue that through the partnership of the government of Zimbabwe with the various non-governmental organizations, smallholder farmers practicing conservation farming were supported with fertilizer, seeds and training. According to Nyathi (2013), the ultimate idea was to see the successful

adoption of conservation farming in Zimbabwe yielding the anticipated outcomes of improving agricultural productivity.

Marongwe et al. (2015) conducted an investigation and established that in Zimbabwe, the resolution to adopt conservation farming practices was involuntary. Smallholder farmers who pioneered the advancement of conservation farming were identified by non-governmental organizations as helpless smallholder farmers who were not spared from the realities of climate change as exhibited by the low agricultural productivity in their farms (Nyathi, 2013). Smallholder farmers were then supported with farming inputs and adequate support from the agricultural extension officers, as motivations to implement conservation farming systems (Marongwe et al., 2015). Mazvimavi et al. (2011) concur that the scaling of conservation farming advocacy was pioneered by various partners through offering input assistance to smallholder farmers. Nyathi (2013) posits that the motivation to implement conservation farming was driven by the expectation to receive assistance from non-governmental organisations. Mazvimavi et al. (2011) argue that, there was an increase in non-governmental organizations that were encouraging the implementation of conservation farming in Zimbabwe. Twomlow et al. (2008) explain that since 2004, the use of conservation farming has continued to be encouraged to over 100,000 smallholder farmers in Zimbabwe through a combination of partnerships with non-governmental organizations and government departments with the hope of increasing crop productivity.

Mazvimari et al. (2010) argue that the impacts of conservation farming that have been achieved in improving agricultural productivity for smallholder farmers in the dry regions of Zimbabwe need to be assessed so as to find a sustainable way of improving the effectiveness of conservation farming in improving agricultural productivity. According to FAO (2010), a study was done on a conservation farming trial experiment that began in 2006/2007 and was repeated in 2007/2008 across fifteen districts in Zimbabwe where various non-governmental organisations working together to promote the use of conservation farming collaborated to do an analysis on the outcomes of using conservation farming. The assessment was conducted through interviewing sixteen households from the fifteen districts (FAO, 2010). Output yields of maize from the various sub plots that had farmers making use of conservation farming and those making use of the

conventional method of farming were recorded and results indicated that there was no significant difference in the output yield for the two groups of farmers (FAO, 2010). According to FAO (2010), the various partners who conducted the study responded to the results through offering further training on the use of conservation farming without taking a deep dive into the challenges affecting smallholder farmers as they make use of conservation farming and in also understanding the nature of conservation farming being practised in Zimbabwe. As a result, yield output of maize has remained low, prompting Zimbabwe to take the leading award of being a net importer of maize to reach the demands of the nation's food security needs (GOZ, 2018).

According to Twomlow and Hove (2006), ICRISAT in Bulawayo conducted an evaluation to establish the outcomes of conservation farming on maize yields in comparison to output yield of maize for those farmers using the conventional method of farming. This is a study that was conducted around eight districts in the southern region of Zimbabwe in 2004 to 2005 farming season (Twomlow and Hove, 2006). Results from the assessments revealed that there was no significant difference in the yield output for those using conservation farming and those using the conventional method of farming during the 2004 to 2005 farming season across the eight districts (Twomlow and Hove, 2006). Twomlow and Hove (2006) confirm that this outcome was attributed to the inexperience of the Agricultural Extension Officers that were responsible for the training of smallholder farmers in the use of conservation farming. Aspects to do with input challenges and limited monitoring visits by the Agricultural Extension Officers to the smallholder farmers also emerged as a challenge relating to the failure by the approach to yield the anticipated results (Twomlow and Hove, 2006). It is from this background that this study sought to assess the challenges that are affecting smallholder farmers in using conservation farming in Zimbabwe. An understanding of these dynamics was key in framing a conservation farming model that takes into account various challenges affecting smallholder farmers through an empathy process with the smallholder farmers who are the ones affected by the intervention.

A further study that sought to compare the output yields from farmers making use of conservation farming and those making use of the conventional method of farming in Zimbabwe was conducted by a group of stakeholders working in the Matabeleland provinces of Zimbabwe in 2005 (Wagstaff



and Harty, 2010). Wagstaff and Harty (2010) claim that the results from the study revealed that the yields of smallholder farmers making use of conservation farming were only three percent higher than those making use of the conventional method of farming. In response to the results, the various stakeholders recommended the need to promote micro dosing of fertilisers as part of the package of making use of conservation farming. (Wagstaff and Harty, 2010). As a method of improving the effectiveness of conservation farming in improving crop yields, Wagstaff and Harty (2010) explain that various partners recommended the need for conservation farming plots to be divided in a way that promoted intercropping in one single farming season through ensuring that half of the area was under maize as the staple food and the other part distributed evenly between groundnuts, cowpeas and sorghum. The methodology entailed empowering the lead farmers to train and demonstrate the merits of using conservation farming (Wagstaff and Harty, 2010). The impact assessment of incorporating the lead farmers reported the need to understand underlying factors resulting in resistance on the adoption and maximum utilisation of conservation farming (Wagstaff and Harty, 2010). Based on the political occurrences of 2008, donor partners who were involved in the support of conservation farming pulled out, leaving a further gap in the analysis of the role that lead farmers played in improving crop yield (Twomlow, 2009). Upon the formation of the government of national unity in 2010, the promotion of conservation farming continued and hence it was critical for the study to assess if conservation farming is now providing a significant output harvest for smallholder farmers who have adopted it in comparison to those smallholder farmers who are making use of the conventional method of farming (Twomlow, 2014). A comprehension of the association between conservation farming adoption and increase in agricultural productivity was a key starting point in the development of a solution based model of improving the effectiveness of conservation farming.

#### **1.4 Conservation farming and the development agenda**

An average 75 % of communal lands are situated in the agro-ecological regions four and five in Zimbabwe (Mudimu, 2014). In explaining the agro ecological regions four and five, Ncube et al. (2012) posit that districts in those regions are characterized by low, unreliable and erratic rainfall usually ranging below 600mm per annum, hence being classified as low to below average rainfall

patterns. The type of crops grown in these regions include the drought resistant crops that incorporate small grains comprising of millet and sorghum, with the only cash crop grown being maize as it is the staple food (Mudimu, 2014). Harfold and Breton (2009) posit that the extreme weather conditions experienced in region four and five which are characterised by high temperatures result in an increase in transpiration and evaporation rates and this, together with the erratic rainfall patterns, leaves the regions prolonged to droughts. With this in mind, Cunningham (2016) explains the double challenge that Zimbabwe has when it reflects globally to other countries that include Israel. The challenge is to understand how a country like Israel that gets an average of 230mm of rain annually, which is a third of what the dry regions of Zimbabwe are getting with an average of 600mm of rain annually, can be able to export food globally (Cunningham, 2016). Again a closer look globally at California, which is said to be the driest state in the United States of America, reveals that California is able to produce 90% of the tomatoes as well as other crops being consumed in America despite the dry weather conditions experienced in the state (Cunningham, 2016). Hence this presents the need to address the effects of conservation farming to develop a model that will serve as a driver of improving agricultural productivity in Zimbabwe.

Due to the low agricultural productivity in Zimbabwe, an estimated six million people are food and nutrition insecure (Mazvimari et al., 2010). According to Twomlow (2014) smallholder farmers in regions characterized by limited rainfall patterns are the most affected by this situation. It is against this background that the response to the food insecurity affecting smallholder farmers and the communities in Zimbabwe has been in the form of food aid without a deliberate exit and sustainable strategy for reducing the dependency web (Cunningham, 2016). It is through this challenge that achieving household food security through increasing agricultural productivity is a key development agenda that has been driven through the growing advocacy for the implementation of conservation farming (Mazvimavi and Twomlow, 2014).

Gukurume et al. (2010) evaluated the outcomes of using conservation farming in Chivi district, Masvingo province of Zimbabwe. Findings from the evaluation revealed that after implementing the use of conservation farming, households in Chivi district were deeply food insecure (Gukurume et al., 2010). Gukurume et al. (2010) confirm that conservation farming had failed to

improve crop productivity because the development actors who were actively involved in the implementation of conservation farming did not consider the unique realities of the programme clients in Chivi district. The recommendation from the study was the need for research that will take an active role in understanding the unique challenges faced by the smallholder farmers in the implementation of conservation farming and their perceived ideal conservation farming model (Gukurume et al., 2010).

### **1.5 Conservation farming in the context of the sustainable development goals**

Zimbabwe has committed itself to the achievement of Agenda 2030 through devoting itself to the deliberate execution and realisation of the sustainable development goals (UN, 2018). Marongwe et al. (2015) are of the view that the critical need for achieving food security through increasing agricultural productivity is due to the development need to achieve the sustainable development goals related to poverty reduction. The understanding is that the ability of smallholder farmers to increase agricultural productivity will lay the fertile ground for them to be able to sell some of their produce, which is instrumental in equipping them with the economic capacity to access basic services and in turn play a role in the reduction of poverty (Gukurume et al. 2016). There is no doubt that increasing agricultural productivity is critical to the achievement of Sustainable Development Goal Number Two related to ending hunger through attaining food and nutrition security (UN, 2018). Twomlow (2014) argues that improving maize yield is directly related with access and availability of food, bearing in mind that maize is the staple food in Zimbabwe. Sustainable Development Goal Number Three relating to the general wellbeing of the citizens of Zimbabwe can be met if the communities in Zimbabwe have access to nutritious food (Kanyenze et al., 2011). The UN (2018) emphasizes that it is critical to note that the sustainable development goal on education which seeks to ensure inclusive and equitable quality education and life learning opportunities for all is also indirectly related to the need to increase agricultural productivity. This is because the sustainable development goal on education, through its indicators, recognizes the need for children to develop in a healthy manner based on good nutrition (UN, 2018). In the same

vein, having access to food enhances the chances of communities to have surplus food that they can sell and in turn have the economic capital to send their children to the best learning institutions. This in turn helps in efforts towards realising the sustainable development goal of ensuring inclusive and equitable quality education and life learning opportunities for all (Palm et al., 2018).

Improving crop yields will also play a critical role in the realisation of Sustainable Development Goal Number Five of achieving gender equality and empowering all women and girls (Dube, 2015). A considerable number of women have taken up smallholder farming and their success in improving crop yields will also spur other women to be able to take up opportunities in the agricultural sector which in turn is part of the reforms needed to give women equal rights to economic resources. The key indicator in this sustainable development goal is the proportion of women in agriculture with access to land and being able to produce meaningfully from that land (UN, 2018). Ultimately, the effective use of conservation farming is vital in meeting the Sustainable Development Goal Number Thirteen of climate action (Palm et al., 2016). Sustainable Development Goal Number 13 places emphasis on taking urgent action to combat climate change and its impacts through awareness, and raising human and institutional capacity on climate change mitigation and adaptation (UN, 2018). The idea is to empower communities to develop climate resilient approaches to improving crop yields.

## **1.6 Conservation farming in the context of Agenda 2063**

Dube, Sithole and Ngwenya (2018) explain that Zimbabwe, being a member state of the African Union, has committed to Agenda 2063 with a vision of a united thriving Africa driven by its own populace. According to Dube et al. (2018), one of the priority areas of Agenda 2063 is that of poverty reduction through the use of agriculture. Tankou (2016) posits that agriculture has a part to contribute as an enabler to Africa's food and nutrition security and in turn poverty reduction. However, it is critical for Africa's agriculture - including that of Zimbabwe - to be developed into a contemporary and vibrant sector through investment in climate smart technologies and infrastructure to link agricultural markets across the African continent (Dube et al., 2018).

According to Bafana (2018), the need to address the effects of conservation in Zimbabwe is a key step in the investment on climate smart approaches that are instrumental in ensuring that agricultural productivity is enhanced through increasing crop yields. This will be instrumental in meeting the food security needs of the nation of Zimbabwe and ultimately those of the African Union, hence this is a vital road to poverty eradication.

Crop productivity is critically low in the African continent due to limited suitable crop varieties and crop production technologies (Harfold and Brenton, 2014). Dube et al. (2018) posit that the African plight is further exacerbated by the reality that the majority of the rural households are faced with an insurmountable challenge to do with productive resources that include animal draught power, fertilizers and improved seed varieties as well as the climate challenges associated with unreliable rainfall patterns. As such, various actors in the development discourse in Zimbabwe are introducing various interventions that are aimed at improving the livelihoods of community members (Harfold and Breton, 2014). This is the reason why the use of conservation farming has been spearheaded in Zimbabwe with the aim of improving crop productivity; however, so far it has failed to yield the anticipated outcomes (Bafana, 2018). This brings out the deliberate need to assess the effects of conservation farming in Zimbabwe with an intentional approach of providing a solution based model to the challenges facing smallholder farmers.

### **1.7 Problem statement**

According to Mashango (2015), the introduction of conservation farming as a strategy to augment agricultural productivity in Zimbabwe has yielded little results. The research made a deliberate focus on the agricultural productivity of maize considering its important role as the staple food for the greater number of the Zimbabwean population (GOZ, 2018). During the two decades before the introduction of the fast track land reform programme, Zimbabwe played a significant role as the prime producer and exporter of maize for its neighbouring countries (Woodend, 2011). However, over the past 19 years, the production of maize has significantly declined resulting in an increase in imports by the government of Zimbabwe and the private sector (GOZ, 2018). The increase in imports is necessitated by the need for the nation to maintain annual reserves of at least

500 000 tons of maize (GOZ, 2018). This is a big challenge perpetuated by the foreign currency crisis that the country is faced with, hence stimulating the need to urgently increase agricultural production of maize in order to meet the nation's food security needs as well as generating foreign currency for the country once it is able to also export (Musarurwa, 2018).

Maize production per hectare in Zimbabwe is one of the lowest when a comparison is made with other countries in Sub Saharan Africa, matching that of Mozambique but being surpassed by South Africa, Malawi and Zambia over the past 15 years (Basera, 2015). Mutenga (2015) explains that due to the changing climatic conditions that are characterised by droughts, Zimbabwe's maize productivity has significantly declined with output yield per hectare decreasing from an average 0.85 tonnes per hectare to an average 0.48 tonnes per hectare. As a result, the country has to import an average of at least 900 000 tonnes of maize to meet the annual national requirements of 1.8 million tonnes of maize to ensure food security in terms of availability and access to food (GOZ,2018). According to Nkala (2014,) an analysis of the situation across the provinces of Zimbabwe from the year 2013 to 2015 farming season reveals an urgent need to address the effectiveness of climate smart approaches such as conservation farming that have been implemented to improve agricultural productivity. Mutenga (2015) argues that maize yields in Mashonaland East declined from 0.80 tonnes per hectare to 0.43 tonnes per hectare, Mashonaland Central yields declined from 1.27 tonnes per hectare to 1.05 tonnes per hectare. Mutenga (2015)explains that in Mashonaland West yields decreased from 1.28 tonnes per hectare to 0.93 tonnes per hectare. In Manicaland maize yields per hectare decreased from 0.80 tonnes per hectare to 0.43 tonnes per hectare (Mutenga, 2015). The situation in the Southern Region of Zimbabwe is in a worse state where Masvingo province maize yields are at an average 0.14 tonnes per hectare, with the Midlands having an average 0.27 tonnes per hectare, the Matabeleland South province with an estimate of 0.48 tonnes per hectare and Matabeleland North, with an estimate of 0.18 tonnes per hectare, being the lowest producer of maize per hectare across all the provinces of Zimbabwe (Mutenga, 2015). In the Global Agricultural Report of 2016, GHI (2016) explains that the challenge globally is that agricultural productivity is not improving at the rate that is required to cater for the requirements of an expanding population that is estimated to be at 10 billion people in the year 2050. The total factor productivity report of 2016 further outlines that the state of

agricultural productivity, particularly in low income countries ,is disheartening at 0.96% down, from 1.5% three years ago, yet the development agenda as detailed by Sustainable Development Goal Number Two requires smallholder farmers in low income countries to produce twice what they are currently producing through the implementation of resilient agricultural approaches such as conservation farming that support the capacity of crops to thrive in a changing climate characterised with unfavourable weather conditions and droughts (GHI, 2016:36).

A deeper analysis of Matabeleland North province taken from the ZIMVAC Report of 2016 revealed that approximately six percent of the rural people in Umguza District require about 21 000 metric tonnes of maize as food assistance in view of the current food insecurity that is affecting the district as a result of low agricultural productivity (ZIMVAC, 2016). According to the report, the incidence of households consuming poor diets had fallen from eleven percent (11%) to six percent (6%) in the period April 2013 and April 2016 (ZIMVAC, 2016). Therefore, the study sought to examine whether the low agricultural yields experienced in Umguza District are the same for farmers adopting the conservation farming approach and those adopting the conventional farming method. The idea was to bridge the gap through providing solutions of a farming approach that will be effective in increasing the agricultural productivity of maize which is instrumental in augmenting the sustainable livelihoods of smallholder farmers in Zimbabwe. Mazwi, Chambati and Mutodi (2015) argue that the post 2000 land reform programme was implemented 17 years ago, however, Zimbabwe continues to experience low agricultural productivity which translates to recurrent food insecurity, yet the objective of the programme was to empower the local people to advance agricultural productivity through the adoption of methods such as conservation farming. According to GOZ (2018), the challenge for Zimbabwe is to produce well over 1.8 million tonnes of maize and this propels the need to increase the output yield per hectare of maize to an average of two tonnes per hectare through the implementation of climate smart resilient approaches such as conservation farming. However, despite decades of implementing approaches such as conservation farming, maize yields have in fact declined. Nevertheless, the adoption of such resilient farming approaches is an innovation aimed at increasing agricultural productivity despite the harsh climatic conditions (Dube, 2016). Based on this context, the researcher sought to assess the effects of conservation farming in Zimbabwe through understanding the nature of conservation

farming implemented in Zimbabwe, the challenges and benefits experienced by the smallholder farmers as they make use of conservation farming, the factors that determine the adoption of conservation farming, as well as understanding if there are differences in the output yields of maize per hectare between smallholder farmers making use of conservation farming and those making use of the conventional method of farming. The intention of the study emanated from the need to develop a sustainable model of conservation farming that takes into account the unique needs of smallholder farmers and takes an active role in doubling agricultural productivity as a necessity to meet the development needs of Zimbabwe as well as the global needs of a growing population.

## **1.8 General objective**

The main objective of the study was to examine the effectiveness of conservation farming in improving agricultural productivity in Umguza District.

### **1.8.1 Specific objectives**

- To analyse the nature of conservation farming implemented among smallholder farmers in Umguza District.
- To examine the association between conservation farming adoption and increase in agricultural productivity.
- To identify challenges and opportunities in the utilisation of conservation farming in Umguza District.
- Assess factors that determine the adoption and maximum utilization of conservation farming.
- To develop a prototype for implementing conservation farming systems in Umguza District.



## **1.9 Research questions**

- Is conservation farming an effective method of increasing agricultural productivity in Umguza District?
- What is the nature of the conservation farming method implemented in Umguza District?
- Is there an association between conservation farming adoption and an increase in agricultural productivity?
- What are the challenges and opportunities in the utilisation of conservation farming in Umguza District?
- What are the factors that determine the adoption and maximum utilisation of conservation farming?
- What prototype can be used to implement conservation farming systems in Umguza District?

## **1.10 Scope of the study**

The research analyzed the effects of conservation farming in Zimbabwe focusing on smallholder farmers in Umguza District practicing conservation agriculture as against those using the conventional method of agriculture. The idea was to establish whether or not the adoption of conservation agriculture is an effective method of increasing agricultural productivity. Focus was made on the agricultural productivity of maize since maize is the staple food in Zimbabwe; hence it is important for the sustainable livelihoods of smallholder farmers. Umguza District has a population of 19500 households in 19 wards, with 87513 people having an average of 4.5 individuals per household (Nkala, 2015). Thus the study purposively sampled wards 9 and 12 in Umguza District, intentionally neglecting other wards that are largely comprised of commercial farmers. The study also purposely sampled Agricultural Extension Officers who have valuable knowledge on farmer experiences in Umguza District.

### **1.11 Limitations of the study**

The limitation to this study was that the research could not ascertain the counterfactual in the sense of what could have been the state of agricultural productivity for the treatment group in the event that conservation farming had not been introduced bearing in mind different confounding factors that affect agricultural productivity. The researcher, however, ensured that the participants in both the treatment and control groups were exposed to similar environmental conditions as they were selected from similar districts, experiences and wards to offset the counterfactual challenge.

### **1.12 Importance of the study**

Nkala et al. (2015) note with concern the slow adoption of conservation farming in Zimbabwe yet this is an approach that is aimed at increasing agricultural productivity and improving food security. The study was vital in establishing the challenges that affect smallholder farmers resulting in the slow adoption of conservation farming. Increasing agricultural productivity is crucial in helping developing countries leapfrog their movement from being low income countries to becoming upper middle income countries (UN, 2018). Critical to this vision for developing countries is to achieve food and nutrition security as well as improve the sustainable livelihoods of community members (FAO, 2013). The research is critical in providing an empirical methodology that development partners can harness as they assess the effectiveness of innovative agricultural systems in the value chain of crop production. The research is important as it further provides a prototype for implementing conservation farming that is key in fostering opportunities for further research in running experiments and testing the model to establish its value and outcomes in enhancing agricultural productivity. Policy implications contributed by the research are vital in promoting a culture of incubating innovative farming systems that will go a long way in ensuring that smallholder farmers are supported with expert advice as they adopt innovative

farming systems such as conservation farming to a point where they can successfully use the farming systems to transform smallholder farming into commercial farming.

### **1.13 Thesis layout**

**Chapter 1:** The first chapter introduces the land reform programme, emergence of climate change as well as the need to make use of conservation farming in Zimbabwe. The background highlights the development need of increasing agricultural productivity and how conservation farming has been cascaded in Zimbabwe. The chapter highlights the problems faced by smallholder farmers resulting in the need to increase agricultural productivity. The chapter also reviews the background and the context of the research problem through detailing the agricultural sector in Zimbabwe, showing how it has not been spared from the vagaries of climate change, resulting in the need to improve agricultural productivity through understanding the effects of conservation farming in Zimbabwe as a route of moving Zimbabwe from being a low income country to becoming an upper middle income country

**Chapter 2:** The chapter looks at the theoretical framework that includes the theory of participation, the sustainable livelihoods approach, new institutional theory and the diffusion innovation theory. A literature review on conservation farming, climate change as well as agricultural productivity is also presented in this chapter. The chapter also highlights the conceptual framework guiding the study as developed from the concept of adoption.

**Chapter 3:** The methodology chapter presents the plan that guided the study. This includes the research design that was used and the sampling techniques that were employed. Principles of design thinking are also discussed in this chapter, noting their role in the development of a prototype for implementing conservation farming in Zimbabwe. The methods of collecting data that were utilized in the research encompass questionnaires, focus group discussions and in-depth interviews are also highlighted in this chapter, clearly bringing out their strengths and how they were used as data collection methods.

**Chapter 4:** This chapter presents the research findings through narratives, graphs, pie charts and tables. The statistical packages for social sciences were used to analyse quantitative data whilst qualitative data was analysed through thematic analysis and Nvivo.

**Chapter 5:** This chapter brings out the discussions of the study in the context of the objectives guiding the study. Conclusions of the research as well as the study recommendations tied to the prototype of the study are presented in this chapter as the study presents a solution based model to the challenges faced by smallholder farmers.

## **1.14 Conclusion**

The chapter has outlined the background of the study in relation to the post 2000 land reform programme and articulated the necessity to introduce the use of conservation farming in the context of the challenges arising from climate change. A discussion on the agricultural sector and the use of conservation farming in Zimbabwe was presented. This has been done in the context of the research problem that guided the study. The chapter clarified the research problem relating to how low agricultural productivity results in food insecurity from a local, national and global perspective. The objectives guiding the study were laid out together with the research questions that seek to address the study challenge. The value proposition of the research was presented based on the need to leap frog the development of the nation of Zimbabwe from being a low income country to becoming an upper middle income country through investing in smallholder farming.

## **CHAPTER TWO**

### **LITERATURE REVIEW AND THEORETICAL FRAMEWORK**

#### **2.1 Introduction**

This chapter outlines a review of literature that was used to guide this research. In order to give contextual background to the study, the section begins by conceptualizing conservation farming and gives a global overview of the implementation of conservation farming. The researcher unpacks the principles regulating the implementation of conservation farming which is critical in appreciating the differences of conservation farming and the conventional method of farming. The chapter is deliberate in breaking down the historical development of conservation farming across the globe as this outlines the unique context in which conservation farming has been implemented worldwide. The process of implementing conservation farming systems is also discussed as this is critical in understanding whether the implementation of conservation farming systems takes a one size fit approach. This section goes further to explain the notion of climate change in relation to conservation farming also giving indications of how the government of Zimbabwe has responded to the changing climate. The chapter forms the heart of the research as it frames the theoretical and the conceptual frameworks that guided the research plan.

#### **2.2 Conceptualizing conservation farming**

Umar (2012) conceptualizes conservation farming as an approach in agriculture that is based on three important principles that include minimum tillage, diversified crop rotations and permanent soil cover. It should be noted that conservation farming is different from conservation tillage practices that are deemed a step towards conservation farming (Swanepoel and Smith, 2017). Giller (2009) defines conservation farming as a farming technique that protects the original properties of soil, conserving water and in turn results in improved and sustainable production. Conservation farming is a cropping system that has been adopted as the panacea to the challenges

emanating from the harsh impact of climate change on agriculture in Zimbabwe and other that are affected by famine (Pradhan, Idol and Roul, 2016). In the quest to improve agricultural productivity, smallholder farmers in Zimbabwe who are located in areas that experience marginal rainfall patterns have adopted conservation farming with the hope of conserving fragile soils and improving soil fertility. Gukurume et al. (2011) argue that conservation farming implementation has played a role in encouraging the use of small grains that include rappoko, millet and sorghum as well as the adoption of short season crops that mature early than those grown through the conventional farming method. Accordingly, conservation farming is a method that promotes zero tillage and the planting of drought resistant crops that include small grains based on the assumption that the farming method is a panacea in increasing agricultural productivity (Farroq and Siddique, 2015). The conventional farming approach involves complete soil overturn using a hand hoe or the mouldboard plough (Pradhan et al., 2016). Umar (2012) explains that the conventional method of farming is a farming method that is often organized around the farming of maize with food legumes being grown as intercrops. It is against this background that this research sought to establish whether conservation farming and its practices has improved agricultural productivity amongst smallholder farmers in comparison to those smallholder farmers making use of the conventional farming method.

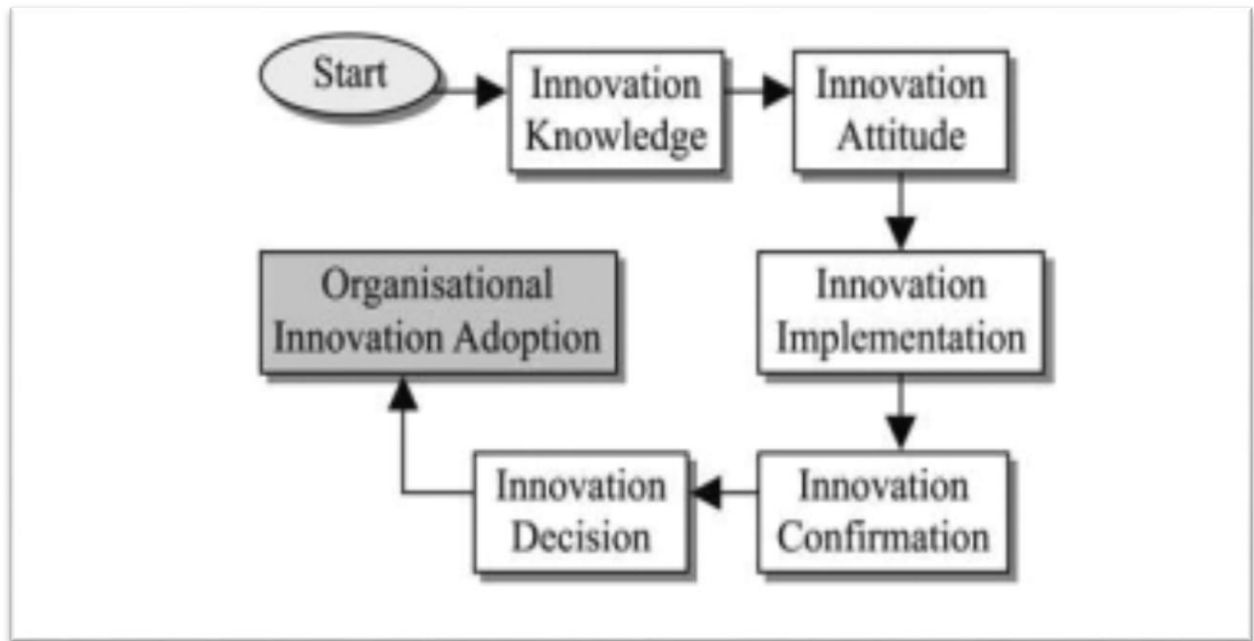
**Table 2.1: Comparisons between conservation farming and the conventional method of farming.**

	<b>Conventional Farming</b>	<b>Conservation Agriculture</b>	<b>Rationale</b>
<b>Tillage</b>	Farmers plough and hoe to improve soil structure and control weed	Direct planting without prior inversion of the soil; Planting on the rip line or making holes for planting with a hoe	Ploughing in the long term destroys soil structure and contributes to declining fertility and organic matter levels.
<b>Crop Residue</b>	Farmers remove or burn residue or mix them into the soil with plough or hoe	Crop residue left on the field  Planting of cover crops	Crop residue improves soil structure  Cover crops protect soil from erosion and limit weed growth.
<b>Mix and rotate crops</b>	Monocultures or crop rotations in a tillage framework where the soil is inverted with a mouldboard, plough or similar implements	Crop rotation or intercropping is a permanent feature of the cropping system	Helps maintain soil fertility  Breaks disease cycles

Source: Thombianno and Meshack (2009:13)

## 2.3 CONCEPTUAL FRAMEWORK

### 2.3.1 The concept of Adoption



**Figure 2. 1: Innovation adoption conceptual framework**

Source: Kamal (2006:195)

The conceptual framework explains the relationship between six different stages that affect the adoption concept of a conservation farming system. Imenda (2014) defines a conceptual framework as an end result of consolidating different related concepts to give clarity to the research phenomenon through joining different concepts to give an imagery of conceptual relationships. The concept of adoption guided this study in exploring the effects of conservation farming in Zimbabwe. The concept of adoption was used in reference to the innovation adoption conceptual framework (Kamal, 2006). The need to understand the dynamics of adoption was critical in the analysis of the effects of conservation farming as having an appreciation of the factors that



influence and constrain adoption was critical in building a localised model of conservation farming. Grabowski (2011) conceptualised adoption as the extent to which an individual effectively uses new technology upon getting information on its purpose and related advantages.

Friedrich (2014) explains different factors that constrain the adoption of a farming approach. Having an understanding of these factors was vital in tracing if they affect the effectiveness of conservation farming in improving agricultural productivity. The first variable that affects the adoption of an innovation has to do with the lack of sufficient experiential knowledge which is described as an intellectual constraint (Friedrich, 2014). This is a concept that Kamal (2006) terms innovation knowledge. This constraint is related to limited available information on the implementation of conservation farming systems (Grabowski, 2011). Friedrich (2014) argues that limited experiential knowledge on the use of conservation farming systems stemming from the reality that the adoption of conservation farming across the globe is limited, accounting for only seven percent of the total land under conservation farming may affect the adoption and maximum utilisation of conservation farming.

Analysing access to training and provision of information related to the use of conservation farming was vital in assessing the role of training as an independent variable in affecting the decision to adopt the use of conservation farming and increase agricultural productivity. According to Redd (2009), the understanding is that it is critical for the smallholder farmers to have adequate knowledge or information on the innovation to effectively make use of the farming approach. Friedrich (2014) argues that adoption of a farming approach is affected by the extent to which the local community has been involved right from the beginning of introducing an approach. The active engagement of the community is vital in influencing innovation knowledge and in turn affects the effectiveness and sustainability of the adopted farming approach. The implication is that when smallholder farmers perceive that they have not been involved in the design of conservation farming systems, this may affect the extent of adoption and ultimately the effectiveness of conservation farming (Kamal, 2006).

One of the greatest challenges associated with the adoption of an innovation develops as soon as the immediate fast adoption of the innovation occurs when the advantages of using the approach are obvious and lead to fast acceptance and enthusiasm; however, the enthusiasm is eroded once the approach is understood and its disadvantages are prevalent (Kamal, 2006). It was critical for the study to establish if the perceived disadvantages of using conservation farming systems outweigh the benefits of using the approach.

Innovation attitude is the second key variable that affects the adoption of an innovation (Friedrich, 2014). Kamal (2006) argues that adoption is affected when problems of an approach are perceived to exceed the benefits of adopting that particular approach. The implication is that once a negative perception is formed upon the adoption of an innovation then it is highly unlikely that the approach will be adopted and if adopted then it is highly likely that it will not be effectively implemented, hence affecting the maximum adoption and utilisation of conservation farming. Friedrich (2014) posits that individuals are conservative and risk averse and this plays a critical role in affecting the adoption of an innovative approach. This demands that smallholder farmers form a positive attitude towards the innovation so that they can act independently on the decision to adopt the use of conservation farming. This understanding resulted in the need to establish if smallholder farmers were not coerced to implement conservation farming systems and to also assess the relationship between demographic details and the adoption of conservation farming which in this case demanded the need for smallholder farmers to take risks and implement the new farming approach.

Innovation implementation is an important variable that precedes the formation of an innovation attitude (Kamal, 2006). It should be noted that the concept of adoption at this stage is affected by biophysical and technical constraints which are related to the unique environment of the smallholder farmers (Redd, 2009). Mkonda and He (2017) posit that the implementation of conservation farming requires the deliberate use of reduced or no tillage, soil cover and crop rotations to increase agricultural productivity and in turn improve food security. Analysing the implementation of the key variables underpinning the use of conservation farming was instrumental in understanding the nature of conservation farming being practiced in Zimbabwe. Having an understanding of whether these key principles were used in the innovation

implementation of conservation farming systems was vital in assessing the extent to which the application of these principles is feasible considering the unique context of smallholder farmers in Zimbabwe.

Kamal (2006) underscores that innovation confirmation is central to making the process of adoption effective and sustainable. For the concept of adoption to be effectively implemented it is critical to make use of role model farmers which includes farmers with good social standing in society (Mkonda and He, 2017). This serves as a motivator in influencing the adoption and maximum utilisation of conservation farming. In this regard the concept of adoption relies on the influence of significant others and various networks in motivating smallholder farmers to adopt the use of conservation farming. An understanding of social capital was vital in assessing the role of relationships in propelling the adoption conservation farming (Treed, 2015).

Innovation decision is the stage that follows the innovation confirmation stage in affecting the concept of adoption (Kamal, 2006). At this stage it is crucial to understand how different livelihood capitals affect the adoption decision. The challenges that may affect adoption at this stage include those that are related to the financial capital, physical capital and natural capital (Treed, 2015). Friedrich (2014) posits that financial challenges may affect adoption even if the benefits of the approach are clearly visible. In addition, infrastructure constraints that are related with access to irrigation schemes as well as other vital inputs to use in the farms also have a role to play in affecting the concept of adoption (Mkonda and He, 2017). An understanding of the role played by access to the different livelihood capitals was essential in establishing if access to the capitals has an influence in affecting the decision to adopt the use of conservation farming and in also affecting the impact of conservation farming in terms of the increase in agricultural productivity. This played an important role in understanding the challenges and opportunities associated with the use of conservation farming.

Overall adoption of an innovation is the final stage in the cycle that affects the adoption concept in effectively implementing conservation farming systems (Kamal, 2004). According to Treed (2015) this stage is reliant on the individual's ability to appreciate the opportunities that come with

the adoption of an innovation. The ability to fully adopt conservation farming systems lies on the smallholders' understanding of the opportunities that come with the use of conservation farming systems that include the utilisation of the approach as a climate change mitigation approach which is key in improving food security for the smallholder farmers bearing in mind the realities of droughts that are affecting communities (Treed, 2015). This brought about the need to assess if smallholder farmers fully appreciate the benefits and opportunities that come with the use of conservation farming. This was critical in understanding the uptake of conservation farming in Zimbabwe as well as the outputs that come with the use of conservation farming systems. Treed (2015) explains that the rate of adoption of innovations may also be influenced by variables other than the characteristics of innovations such as the type of the innovation decision, the type of communication channels used and the promotional efforts of change agents. Kamal (2006) claims that innovations that can easily be trialled and produce benefits that are easily observed are likely to be adopted more rapidly than innovations that are difficult to trial and produce benefits that are difficult to observe.

## **2.4 Historical development of conservation agriculture**

In a bid to explain the historical development of conservation agriculture, Farrooq and Siddique (2015) traced the development of conservation agriculture from the early 1930s when the use of the conventional method of farming that is characterized by the use of tillage practices was first questioned by Faulker (1943) in his manuscript titled "Plowman's Folly" (Farroq and Siddique, 2015). Friedrich, Derpsch and Kassam (2012) assume that the shift to conservation agriculture came at a time when tillage practices had been used for over a million years when humans diverged from hunting to the more traditional method of agriculture. Baig and Gamache (2009) argue that in 1943 the development of machinery that made seeding possible without the need to till the soil went a long way in promoting the adoption of conservation farming. Hagblade and Tembo (2003) add that challenges associated with the rise of fuel prices attracted farmers to shift from the conventional way of farming through the adoption of innovative resource saving farming systems.

Ultimately, the idea of adopting conservation agriculture was to combat drought induced soil erosion at a minimum cost (Farroq and Siddique, 2015).

Farroq and Siddique (2016) posit that the experiences of conservation agriculture observed from the United States of America motivated for the adoption of conservation farming in South Africa. Friedrich et al. (2012) believe that this is the point at which farm practices compatible to no tillage farming began to improve. Around 1990, various organizations developed an interest in promoting the adoption of conservation agriculture. The role played by these organizations was influential in spreading the implementation of conservation farming in Asia, South America, Africa and Europe (Farroq and Siddique, 2016). Friedrich et al. (2012) posit that today conservation farming is being practiced across millions of hectares around the world. The adoption rate of conservation farming has tremendously increased over the years to an average 10 million hectares per year due to the positive effects it has in terms of crop yields (Farroq and Siddique, 2016). Friedrich et al. (2012) claim that of the total space covered by conservation farming worldwide, 45% is in South America, 32% in United States of America and Canada, 14% in Australia and New Zealand and 9% in the rest of the world including Asia, Europe and Africa.

## **2. 5 Overview of conservation farming globally**

There has been a significant increase in the use of conservation farming across the globe. Derpsch and Kassam (2015) are of the view that conservation farming has been implemented worldwide on an area of land covering an average one hundred and seventeen million hectares in all continents and all agricultural ecologies that range from different environments. The fast growth of conservation farming has been experienced mainly in South America in nations that include Argentina, Brazil, Paraguay and Uruguay and are said to be practicing conservation farming on about 70% of the total cultivated land (Derpsch and Kassam, 2015).



**Figure 2.2: The adoption of conservation farming across the world**

Source: Kasam (2015:15)

### 2.5.1 North America

According to Giller (2015) countries that are practicing conservation farming in North America include the United States and Canada. Derpsch and Friedrich (2010) indicate that conservation farming between 2004 and 2007 amplified from 23.2% to 25.5% of total cropland acres. The implication is that there has been a rise in the uptake of conservation farming by smallholder farmers although the majority of the farmers are still using the conventional method of farming. In Canada, the majority of farmers who are using the conventional farming method are the elderly

farmers who have been practicing the conventional farming method for a long period of time (Giller, 2015). As such, it is estimated that the change in the farming methods will only be possible when the land changes hands (Derspsch and Friedrich, 2010).

Hansen (2014) explains that the adoption of conservation farming in North America has been widespread and has increased significantly. According to Giller (2015), the adoption of conservation farming has been significant in regions that are not entirely affected by cold weather conditions during the growing seasons. The major challenge faced in North America conservation farming has been that of seeding and the failure to control weeds (Derspsch and Friedrich, 2010). The need to embrace soil conservation in North America was triggered by the Dust Bowl in 1930 which saw the North American countries being severely affected by dust storms characterized by an intensive drought that greatly destroyed the agriculture system. In this case there was need to implement a farming method that could survive wind erosion (Giller, 2015). Three critical factors resulted in the smooth adoption of conservation farming in North America. These include the effective release of herbicides between the years 1960 and 1970 that were important in the removal of unwanted weeds; direct seeding made possible through the availability of no till planters; and government policy that supported the transition to conservation farming (Hansen, 2014).

A study done by the Ohio Institute on the Brandt farm with the aim of comparing crop yields for farmers practicing conservation farming and those adopting the conventional method of farming revealed that corn yields were significantly improved by 36% to 44% on those using conservation farming compared to those using the conventional method of farming whilst using the same rate of supplement N fertilizer (Islam and Reeder, 2014). Islam and Reeder (2014) posit that research at Brandt farm in Ohio concluded that conservation agriculture provided various agronomic and economic gains to the producers through its ability to sustain higher crop yields. Extending the principles of conservation farming, which is viewed as a vital global movement, is fundamental in meeting the food security needs of the 21<sup>st</sup> century (Islam and Reeder, 2014).

### **2.5.2 South America**

According to Giller (2015), South American countries that have spearheaded the adoption of conservation farming include Brazil, Argentina, Paraguay, Bolivia, Uruguay, Venezuela, Chile and Colombia. Brazil is said to be one of the leading countries in the adoption of conservation farming with about 70% of the farmers who use the no tillage method using it permanently (Derspch and Frieddrich, 2010). Kassi and Zikhali (2009) agree with Derspech and Friedrich (2010) indicating that conservation farming has become the chief agricultural approach in South America being applied on 70% of crop land. Brazil is said to be the first country to have adopted the use of conservation farming in South America in response to severe soil erosion and soil degradation rates (Ekboir, 2003). Derspech and Friedrich (2010) claim that the rapid and continuous development of conservation farming in Brazil is attributed to the machine industry that engaged early in the specialization of no till equipment. In light of this, the research sought to establish whether smallholder farmers adopting conservation farming in Zimbabwe have the necessary equipment needed to successfully implement this type of farming approach.

Derspch and Frieddrich (2010) argue that Argentina is part of the countries that were able to effectively undertake the adoption of conservation farming. Speratti (2013) notes that the adoption of conservation farming in South America has had the highest adoption rate in comparison with other continents. Kassi and Zikhali (2009) posit that the success of conservation farming has largely been ascribed to a number of reasons that entail the tied partnership between the government, private sector and research centres. According to Derspch and Frieddrich (2010) the need to adopt conservation farming in South America emerged due to the need to deal with the challenge of widespread soil degradation characterised by soil erosion. The use of the conventional method of farming thrived on European soils but proved to be ineffective for tropical soils characterised by truncated organic matter as the use of conventional farming expanded (Derspch, 2012). Machado and Solver (2001) add that the reduction in production costs as well as the apparent drop in the erosion of soil were part of the forces that played a role in encouraging the adoption of conservation farming first in Brazil and then throughout the South American region.



According to Derspch (2017), in South America, research on conservation farming was first done with conservation farming experiments being initiated by the Meridional Agricultural Research Institute in 1971. The first trial saw two researchers cultivating soya beans using a no till planter, this was a difficult phase that saw farmers who adopted conservation farming moving back to the conventional method of farming due to failure to control weeds (Derspch, 2017). Action points from this key learning experience entailed the establishment of machinery that would place seeds directly to the planting basins as well as continuous testing of herbicides and the utilization of cover crops with the ability to acclimatise to diverse soils and climatic conditions (Solver, 2003).

### **2.5.3 Australia and New Zealand**

According to Rochecouste (2016), it is assumed that over 12 million hectares of land in Australia are under conservation farming with New Zealand having over 16000 hectors of land under conservation. New Zealand is said to be one of the first countries in the globe to make use of conservation farming (Derspch and Frieddrich, 2010). The use of conservation farming over the past five decades in Australia has resulted in a marked improvement of rain fed agriculture (Thomas, Titmarsh, Freebairn and Radford, 2013). Bellotti and Rochecouste (2014) note that farmers in Australia shifted to conservation farming in reaction to the challenge of soil loss as a result of water and wind. In Northern Australia, summer storms that were prevalent before harvesting led to immense loss of top soil and in the process also affecting organic matter (Derspch and Frieddrich, 2010). In the southern and western cropping regions of Australia dominated by lighter soils, autumn dust storms negatively affected farming in those areas removing top soil and in the process having severe impact on soil fertility (Rochecouste, 2016).

The adoption of conservation farming in Australia is geared towards engaging in sustainable farming systems. The guiding belief was that the conventional farming method - with time - was destructive to the soil (Rochecouste, 2016). Bellotti and Rochecouste (2014) add that areas that produce cereal in Australia are susceptible to severe weather conditions characterized by high inconsistency in rainfall patterns which has the potential to affect agricultural productivity. Ward and Siddique (2014) explain that there was a realization by researchers in Australia that the

management of water and soil was fundamental for farming in Australia and conservation farming techniques were understood to be the panacea in increasing crop water use efficiency. The major motivator for the adoption of conservation farming was the famine experienced between the years 1982 and 1990 where pioneer farmers achieved greater results through the use of conservation farming during the time and went on to share their farming experiences with other farmers resulting in greater adoption of the use of conservation farming (Ward and Siddique, 2014). Kirkgaard (2016) posits that through the use of conservation farming, crop yields in Australia are said to have doubled over the past 30- 40 years. Though this notes a positive result following the adoption of conservation farming, additional work needs to be done to make sure that the 30-50% gap between expected yields in experimental plots and what is harvested in the farms is bridged (Derpsch, 2017).

#### **2.5.4 Asia**

According to Derpsch and Frieddrich (2010) China, Khazasktan and India are the leading countries practising conservation farming in Asia. There is an assumption that there are 1.33 million hectares of land under conservation farming in China (Berger, Friedrich and Kienzle, 2016). The adoption of conservation farming in China has enabled the country to produce two successive harvests that include rice and maize as summer or winter crops within the same year (Kassam et al., 2015). Berger et al. (2016) explain that soil erosion as a result of wind and limited water resulting in low agricultural productivity has played a key role in compelling China to adopt conservation farming. According to Kassam et al., (2015) Khazakstan is said to be the one of the ten countries in the world which has a vast section of land totalling 1.3 million hectares which is not being tilled. Government policies in Khazasktan have laid fertile ground for the interest on the adoption of conservation farming (Derpsch and Frieddrich, 2010). According to Berger et al. (2016,) conservation farming adoption in Asia can be traced to research that was conducted in the early 1990's leading to its adoption mainly for the production of rice. In South Asian countries, more than four million hectares of land is under conservation farming and the main crop being produced is wheat (Baig and Gamache, 2009). Berger et al. (2016), however, argue that the implementation of conservation farming systems in Asia is still marginal. The low adoption of conservation

farming in Asia has led to the Indian Professional Alliance for Conservation Agriculture taking an active role in spearheading for the expansion of conservation farming on the continent (Corsi, 2011). This is based on the rationale that the Asian continent has a general interest for resource saving technologies.

Kassam et al. (2015) agree that considerable strides have been made in the implementation of conservation farming in Asia as noted by the increase of 291% of land covered by conservation agriculture between the period 2009 and 2013. This increase comes in the wake of the view that in 2009 there were only two countries that were practicing conservation farming in Asia; however, in 2013 the number of countries practicing conservation had increased to 11 (Corsi, 2011). A remarkable response in the implementation of conservation agriculture has been noted in Kazakhstan which is estimated to have above 10 million hectares of land in the Northern drier regions under conservation farming (Baig and Gamache, 2009). It is in this regard that Kazakhstan is among the topmost countries globally with the biggest area of land with crops supported by conservation farming (Kassam et al., 2009). Nurbekov, Muminjanov, Kassam and Sydyk (2014) point out that Asian countries that include Uzbekistan, Azerbaijan and Kyrgyzstan have also committed to rain fed systems under conservation farming. Fuel shortages in some Asian countries that include Iraq and Syria have also been instrumental in pushing for the adoption of conservation farming systems (Piggin, 2015).

### **2.5.5 Europe**

Kertsz and Madarasaz (2014) concur that the implementation of conservation farming in Europe has been slow compared to other regions. Conservation farming is covering approximately 22.7 million hectares - 25.8% of arable land in Europe (Lamar 2016). Kertsz and Madarasaz (2014) argue that the major reason behind the adoption of conservation farming in Europe is the need to protect the soil against erosion and degradation due to the reality that water and wind erosion occur on 12 and 4% of the total land in Europe respectively. Sloan, Campbell and Alamgir (2012) posit that in as much as conservation farming has been adopted in Europe as a way of mitigating soil degradation and erosion, this farming technique has also been adopted to retain soil moisture in

some parts of Europe as this is critical in ensuring economically viable agricultural production. According to Lamar (2016), retaining soil moisture, which is one of the outcomes of adopting conservation farming, has been critical in fostering drought proofing and promoting the production of economically acceptable yields during dry periods in the semi-arid and Mediterranean regions. Farooq and Siddique (2015) claim that although conservation farming has been used to retain the moisture of the soil during dry seasons, this type of farming also works as a land management strategy for reducing surface run off and surface water pollution as well as reducing the effects of floods on crops particularly in the Northern areas of Europe which are affected by cool and wet climates and predominant long lasting rainfall. Lamar (2016) posits that the reason behind the adoption of conservation farming in Europe is an economic one which places value on improving net returns through reduced labour and operating costs as compared to mitigating soil erosion, hence the reason for the fast spread of conservation farming in Finland and Germany. In a bid to promote the adoption of conservation farming in Europe, the European Conservation Agriculture Federation was established in 1996 with the aim of ensuring that European member countries adopt conservation farming as mainstream agriculture (ECAAF, 2015). According to ECAAF (2015) Europe lags behind in the adoption of conservation farming compared to other regions because the reduction of costs associated with the use of conservation farming are not as important when compared to other continents, hence Europeans are less likely to take risks.

Countries in Europe that have fast adopted conservation farming include Spain, France, Finland, Ukraine and Russia (Derspch, 2017). Derspch and Frieddrich (2010) posit that one of the leading countries in the adoption of conservation farming in Europe is Spain. Despch (2017) posits that conservation farming annually is practiced on 650 000 hectares of land with the main crops including wheat and barley. Conservation farming in Spain is practised on around 10% of the arable land (Derspch and Frieddrich, 2015). In France, conservation farming is practiced on about 200 000 hectares of land, hence the country is part of the most advanced countries in Europe in terms of the adoption of conservation farming (Derspch and Frieddrich, 2010). There was rapid adoption of conservation farming in Finland; this is because those farmers that believed in conservation farming communicated their experiences to their peers and Finland was able to

produce conservation farming machines which were readily available and affordable on the market (Lamar, 2016).

Kertesz and Madrasz (2014) claim that a comparison of yield data in Hungary between farmers adopting conservation farming and those using the conventional method of farming revealed that crop yields increased by 10% for farmers using conservation farming though there are instances where there was a decrease particularly during the first few years of adopting conservation farming. Tourdonnet (2010) argues that in areas that include Ukraine where farmers have adopted conservation farming, crop yields are estimated to increase by 5% - 10% on the Chernozemic soils. Sloan et al. (2007) further highlight that in Southern Europe and Spain yields for farmers using conservation farming have increased ranging from 10% to 15% especially in dry areas. Kertesz and Madarasaz (2014), however, emphasize that considerations on the adoption of conservation farming in Europe are mainly influenced by the desire to reduce operating costs as opposed to the environmental benefits of retaining soil moisture and mitigating against soil erosion and degradation. Sloan et al. (2012) are of the view that the uncertainties of climate change will play a significant role in the evolution of conservation farming in Europe.

#### **2.5.6 Africa**

Many African countries have adopted conservation farming with some of them including conservation farming adoption in their agricultural policies (Thiombiano and Meshack, 2009). Conservation farming activities and promotion programmes have mainly been implemented in Zimbabwe, South Africa, Lesotho, Tanzania, Swaziland, Mozambique, Malawi, Morocco and Tunisia (Brinkman, 2017). Kasam et al. (2015) claim that the global overview of conservation farming has indicated that the success of this farming method was attributed to the availability and affordability of no till technology. The research sought to understand whether Zimbabwe, and in particular farmers in Umguza District, have the no till technology that is needed for this farming method to be implemented effectively. The research also drew experiences from smallholder farmers practicing conservation farming which was critical in analysing the effectiveness of conservation farming in enhancing agricultural productivity.

Thiombiano and Meshack (2009) note that although the adoption of conservation farming in Africa has been slow, this type of farming approach has shown great potential in boosting agricultural productivity and promoting the diversification of livelihoods among smallholder farmers. It is assumed that the total area under the coverage of conservation farming in Africa is less than one percent of the continent's land (Nkala, 2015). This shows the low adoption of the practice in Africa. Kasam et al., (2015) claim that the adoption of conservation farming which is viewed as a sustainable agricultural practice in Africa has been promoted as a means to increase the production of food. This is because conservation farming is believed to be the antidote in addressing the challenge of soil degradation emanating from a culture of farming that destroys the organic matter of soil resulting in the soil losing its fertility (Brinkman, 2017). The slow adoption of conservation farming in Africa birthed the Conservation Farming to Africa Initiative funded by the European Commission that is aimed at exploring the past and ongoing experiences of the practice of conservation farming among smallholder farmers in Africa with the ultimate aim of establishing the critical conditions needed to make the farming practice a success (Nkala, 2015).

Kasam (2015) argues that there was prompt growth of the area under conservation farming from forty five million hectares in 1999 to one hundred and seventeen million hectares in 2012 showing the growing interest in the use of conservation farming among farmers in Africa. Bwayla (2015) postulates that in Africa, despite over two decades of development and spreading of the gospel of conservation farming by various projects and researchers, adoption has been tremendously limited among smallholder farmers. Mazvimavi and Twomlow (2009) posit that there has been rejection of conservation farming by farmers who originally used this farming method but later decided to revert to the conventional method of farming for various reasons.

Milder, Majaneni and Scherr (2011) are of the view that there is a common understanding on the incidence of conservation farming adoption globally, however, approximations differ due to the variations in defining conservation farming adoption. The argument is that the African continent is characterised by numerous circumstances in which conservation farming is not effected comprehensively or permanently (Mazvimavi and Twomlow 2009). Mazvimavi and Twomlow (2009) explain that this is as a result of writers who are said to be including reports on the partial

implementation of conservation farming in their statistics, while others do not. However, Nyathi (2013) argues that these scholars concluded that the variations do not significantly alter the nature of the agreements about the degree of conservation farming adoption in Africa or elsewhere.

The push for conservation farming adoption in African countries that include Zambia was triggered by the drive for transfer of technology spearheaded by large-scale commercial farmers (Haggblade and Tembo, 2003). Upon adopting the use of conservation farming, large scale commercial farmers consequently became solid champions through pushing for the scaling down of conservation farming practices to over 440, 000 farmers in the dry regions of Zambia (IMAG, 2001). Nkala (2015) explains that around the 1970's and 1980's large scale farmers in South Africa and Zimbabwe embarked on a learning experience in the United States of America to understand conservation farming systems. Research teams in Zimbabwe were vital in encouraging commercial farmers in Zambia to adopt the use of conservation farming (Nkala, 2015). Research and experimentation at this stage was thus critical in propelling the adoption of conservation farming among farmers in Africa.

Haggblade and Tembo (2003) note that Zambia would import knowledge from other African countries in a bid to ensure that there is effective knowledge transfer of the farming practice. Haggblade and Tembo (2003) add that a Zimbabwean smallholder farmer was invited as a specialist by the Zambian Golder Valley Agricultural Research Trust. The idea was to help promote the fast adoption of conservation farming in Zambia and also teach farmers on how to implement conservation farming. This process involved a quasi-experiment that compared yields among smallholder farmers who used conservation farming in the experiment and those who used the conventional method of farming. According to Haggblade and Tembo (2003), results from the experiment revealed that produce was greater in conservation farming farms in comparison to conventional farms, twice among maize farms and 60% greater for conservation farming plots growing cotton.

Brinkman (2017) argues that even though studies with evident results have proved that where conservation farming methods have been adopted and yielded valuable outcomes, there is still a

communication gap that has resulted in the stunted growth of the use of conservation farming among smallholder farmers in Africa. According to Bwayla (2015) it is a necessity for countries like South Africa and Zimbabwe to take an active role in advocating for the adoption of conservation farming systems to deal with the challenges of soil erosion and erratic rainfall that are affecting the two countries as a result of climate change and variability. Ward and Siddique (2014) argue that environmental sustainability is the fundamental standard of the 21<sup>st</sup> century. The implication therefore is that the current modes of agricultural production need to be reformed. The argument is that the conventional method of farming that involves the ploughing of the soil before growing a new crop is a leading cause of farmland degradation which ultimately affects agricultural productivity, leaving nations susceptible to food insecurity (Marongwe, Mukora and Linsey, 2016).

According to Mazvimavi et al. (2014), a study was conducted in 2009 where 416 communal farmers who practiced conservation farming received training from the time they adopted the use of no till farming. The survey was done in 15 districts of Zimbabwe. Results from the study revealed that 369 farmers, constituting 89%, had dug planting basins, which was central to conservation farming during the 2008/2009 cropping season. Effectively, the results indicated that eleven percent of the smallholder farmers did not dig planting basins (Mazimavi et al., 2014). Mazvimavi et al. (2014) explain that the reasons given by the farmers for opting out of conservation farming was the removal of farm inputs which include seeds and fertilizer that the farmers would get from support organizations working with them. The explanation for the 11% of the farmers that opted out from practising conservation farming fails to provide key learning experiences on factors that determine adoption of conservation farming (Nyathi, 2013).

Gukurume et al. (2015) carried out another investigation in Zimbabwe and discovered that smallholder farmers throughout Zimbabwe are beginning to realise the importance of using conservation farming innovation as confirmed by the increase in crop yields ranging from 10% to 100% subject to the level of inputs received and the farming experience of smallholder farmers. Nyathi (2013) adds that there have been marked improvements of conservation farming adoption particularly in areas where smallholder farmers have received continuous training on the use of



conservation farming through support by non-governmental organizations. Umuza communal farmers used to practice conventional farming before conservation farming was introduced in 2004 (Nkala, 2014). Harold et al. (2009) confirm that conventional farming is the most practiced approach of preparing land in Zimbabwe using an animal-drawn till.

Rusinamhodzi (2013) challenged conservation farming systems that are supported by donor organizations positing that farmers who habitually have the privilege to access more farming inputs than conventional farmers, given the current breakdown of rural credit schemes, tend to fail once support is withdrawn from them. Nkala (2015) concludes that although considerable effort has been made in ensuring that countries in Africa adopt the use of conservation farming, a gap still remains as there are few studies that have been deliberate in conducting impact assessments to evaluate sustainability of implementing conservation farming in relation to efficiency of inputs invested to conservation farming versus the output harvest of maize produced. Limited studies have also attempted to assess challenges related to the low uptake and scaling of conservation farming practice (Nyathi, 2013). All this is critical in the drive to promote conservation farming as the green revolution to the challenges facing the African continent.

## **2.6 Conservation agriculture process**

According to Mango, Siziba and Makate (2017) the first phase in the implementation of conservation agriculture in Zimbabwe involves the partnership of the state and other organizations. This stage involves equipping Agricultural Extension Officers with critical skills (Diao, Hazel and Thurlow, 2010). The need to equip Agricultural Extension Officers with skills is based on the rationale that the officers have an important role to play at grass root level in developing skills and serving as a support system to smallholder farmers in the community (Diao et al., 2010). Mango et al. (2017) note that experience has shown that support to farmer's practicing conservation farming has been significant in growing the adoption rate of conservation farming. Hence the importance of training Agricultural Extension Officers to provide farmer support.

The second stage in the implementation of conservation farming in Zimbabwe involves defining the extension methods to be adopted (Farroque and Siddique, 2012). This is a process with three different methods that organizations working in Zimbabwe use (FAO, 2017). According to Diao et al. (2010), the first method is the extension agent system which entails Agricultural Extension Officers collaborating directly with various groups of farmers practicing conservation farming. The second method is the lead farmer system that requires trained Agricultural Extension Officers to partner with lead farmers in the community who in turn work with the larger group of farmers and the third method is the combined extension agent system and the farmer support system (Diao et al., 2010). This method deals with Agricultural Extension Officers working directly with farmers practicing conservation farming and in the process selecting lead farmers with an average two to three years' experience who will go on to train future farmers who intend to practice conservation farming (Mango et al., 2017). It is critical that whichever method is used the farmers should have ownership and the vision should be shared with the local gatekeepers (FAO 2017).

The third stage considers defining the role of the extension agent (Farroque and Siddique, 2012)). The assumption at this stage is that farmers should be in a position to carry out experiments on what works or does not work through the assistance of the extension officers (Dia et al., 2010). The Agricultural Extension Officers are merely seen as facilitators of the system. Defining the scope of the project is the fourth stage in the implementation of conservation farming in Zimbabwe (FAO, 2017). According to Diao et al. (2010) farmers at this stage are encouraged to start low and grow over time depending on the season's success. The Agricultural Extension Officers are allocated a maximum of 60 farmers to assist, of which a maximum of 20 farmers should be those trying out conservation agriculture for the first time (Mango et al., 2017). If the project decides to work with lead farmers, the Agricultural Extension Officers should work with a maximum of 10 lead farmers who in turn should work with a maximum of 10 farmers (FAO, 2017). The fifth stage is the entry into the province or district or ward and emphasis at this stage is placed on ensuring collaboration between organizations advocating for the use of conservation farming, the state and the local community (FAO, 2017). At this stage the state plays an instrumental role in lobbying for resources to support the local farmers (Diao et al., 2010). Farmer selection is the sixth stage that entails interacting with the farmers, soliciting for information on farmers cropping problems

and linking those challenges with the benefits of adopting conservation farming (FAO, 2017). Emphasis is placed on ensuring that the farmers who are encouraged to adopt conservation farming stay close to each other (Mango et al., 2017). This is critical in enabling farmers to share learning experiences and in also attracting other farmers in the district to adopt the use of conservation farming.

According to Farroque and Siddique (2012), farmer training and knowledge development is another critical phase in the development of the conservation farming system in Zimbabwe. The rationale at this stage is that the principles of conservation farming radically differ to the conventional method of farming (FAO, 2017). This brings out the need for a deliberate effort to train and equip farmers with knowledge on changing the way of doing things (Farroque and Siddique, 2012). FAO (2017) explains that issues that are discussed at this stage include the benefits of early planting, knowledge on how ploughing can cause damage in terms of loss of organic matter, how soils rich in organic matter are more stable than soils that have been ploughed for many years as well as explain the benefits of mulching that is critical in retaining soil moisture particularly in areas affected by drought (FAO, 2017).

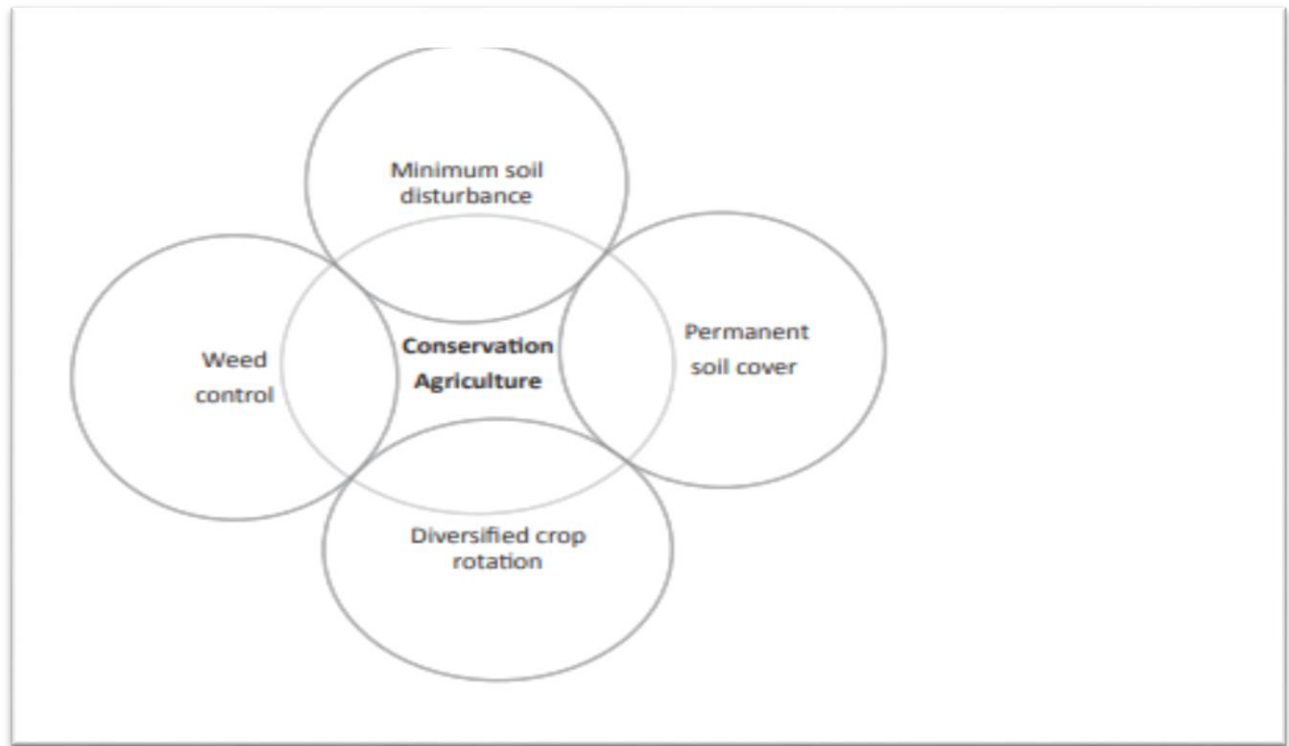
The use of demonstration plots is the stage that precedes the inputs stage. At this stage it is critical to help farmers gain practical farming experience through working with the farmers on a shared area (Farroque and Siddique, 2012). The tragedy of the commons is a devilling challenge that affects Agricultural Extension Officers (Siziba, 2008). However, despite this challenge, it is believed the only way farmers can master the concept of conservation farming is when they collaborate and engage in trial and error (FAO 2017). The demonstration phase helps farmers visualize the difference between using conservation farming and that of using the conventional way of farming (Farroque and Siddique, 2012). The input stage is another critical phase in the implementation of conservation farming in Zimbabwe (Diao et al., 2010). At this point it is critical to ensure that farmers have adequate inputs to make conservation farming successful and sustainable (FAO, 2017). Farmers at this stage can acquire inputs from local non-governmental organizations (Siziba, 2008). Farroque and Siddique (2012) argue that the acquisition of inputs from non-governmental organizations has been subjected to immense debate with academics

fearing that it may result in a dependency syndrome and in the process affect ownership of the project.

According to Farroque and Siddique (2012), government support services are another option that has been used for farmers to access inputs. The major challenge at this point has been the politicization of access to inputs, where farmers have to support a certain political party to be able to benefit from state support (Mazimavi 2011). According to Farroque and Siddique (2012) the third option is for farmers to acquire inputs through sourcing for loans. Mazimavi (2011) posits that this as well has been faced with numerous challenges related to tenure rights. The offer letters given to the majority of the smallholder farmers in Zimbabwe cannot be used as collateral in banks as the state has the right to confiscate the land from the farmers at any given time (Zikhali, 2008). The trading and marketing stage follows the inputs stage (Farroque and Siddique, 2012). This is the point where farmers practicing conservation farming should be aiming at making profit (FAO, 2017). This is critical in helping the farmers meet their personal and community needs related to food security. Farroque and Siddique (2012) explain that at this phase farmers are faced with a number of challenges that include government pricing controls and transport costs of moving their produce to the nearest depot.

Timing of operations and activities is another critical stage in the implementation of a conservation farming system in Zimbabwe (FAO, 2017). It is important to ensure that farmers implement the system effectively with extension services being done precisely and on time (Mazimavi, Ndlovu, Nyathi and Minde, 2011). Farroque and Siddique (2012) conclude that the final stage is that of monitoring and evaluation reporting. This process entails monitoring the activities of farmers, understanding their weaknesses and areas of opportunities in the process providing guidelines to ensure that farmers practicing conservation farming achieve improved productivity (FAO, 2017).

## **2.7 Components of conservation farming in Zimbabwe**



**Figure 2.3: Components of conservation farming in Zimbabwe**

Source: Farroque and Siddique (2015:4)

### **2.7.1 Weeding**

Twomlow (2014) posits that the first critical step in the preparation of land for conservation farming involves removing all weeds. Mhlanga and Muoni (2014) explain that suppressing weeds is a major challenge for smallholder farmers using conservation farming compared to those using the conventional farming method. It becomes imperative to ensure that weeding is done early when the weeds are in their infancy stage (Twomlow, 2014). This is critical in the management of weeds. Singh (2014) argues that the management of weeds is a critical process in the successful implementation and management of conservation farming. Weeds which are found on the upper surface of the soil as a result of not tilling the land result in high weed infestation in conservation farming and the solution to this challenge is the employment of herbicides (Singh, 2014).

According to Mhlanga and Muoni (2014) the process of weeding is done using hand hoes that minimize the disturbance of soil at all costs. In Zimbabwe, this is a process that is done during winter between the period May and June for irrigated crops (Siziba, 2008). Mango et al. (2017) are of the view that one of the possible reasons for the successful outcomes on the implementation of conservation farming in Mozambique is that conservation farming has been implemented in collaboration with other cropping management systems that include the timely management of weeds. The implication is that the selective adoption of the principles of conservation farming that include the management of weeds will negatively affect the anticipated positive theorized results of the adoption of conservation farming (Singh, 2014). The use of herbicides is critical in the controlling of weeds when implementing conservation farming particularly during the first year's adoption for large cropping areas where hand weeding would be inefficient (Rahman, 2017). The process of weeding however provides a challenge for farmers as it is associated with high labour costs for farmers (Mazimavi, 2011). Montt and Luu (2018) argue that there are high costs involved in the implementation of conservation farming and these include the high costs for farm labour which is needed during the period of controlling weeds usually in the primary years, bearing in mind that smallholder farmers plough only an average of 15% of the soil surface when preparing the land. The other challenge that is associated with the process of managing weeds includes the over reliance on herbicides as a means of managing weeds as this poses a problem of environmental pollution and also results in weeds developing resistance to herbicides (Sing, 2014). Rahman (2017), however, argues that the problems of resistance are prevented by ensuring that crops are rotated and by shunning the use of the same herbicide continuously.

Lee and Thierfelder (2017) contend that increase in weed pressure is often an impediment to the successful adoption and implementation of conservation farming in Southern Africa. Rahman (2017) adds that increase in weed density resulting in losses on agricultural produce has been cited as a big challenge in the widespread adoption of conservation farming. This is in contrast with the conventional method of farming where the tilling of the soil is considered as one of the critical factors that promote a favourable environment for the controlling of weeds (Harford and Britton, 2009). The recognition is that there is no single solution that can solve all the challenges associated with controlling weeds that affect the implementation and adoption of conservation farming hence

bringing about the need for integrated weed management innovations that include indigenous knowledge systems in conjunction with modern seeding equipment (Rahman, 2017). Lee and Thierfelder (2017) further highlight that in semi-arid Southern Africa a comprehensive review of strategies that can be made available for smallholder farmers to assist them to manage weeds is lacking. Therefore, hence coming up with solutions on various weed management techniques that farmers can adopt to manage weeds is critical in encouraging smallholder farmers to embrace and sustain the practice of conservation farming.

### **2.7.2 Digging planting basins**

Digging of planting basins is a key component of conservation farming where basins are dug once the land to be planted on has been cleared of weeds (Harfold and Breton 2009). This is a process that is done off the rainy season during the period July to October (Lee and Thierfelder, 2017). Harfold and Breton (2009) note that the recommended dimensions of basins are 15 cm width, 15 cm depth, and 15 cm length. Lee and Thierfelder (2017) note that after the first rains the basins allow farmers to plant the crops after effectively capturing the rain water. The major advantage of the basins is that they allow both organic and inorganic fertilizer to be applied straight into the planting basin (Haggblade and Tembo, 2003). Twomlow et al. (2008) add that the other benefit of planting basins is that they are dug without having to plough the field hence averting the challenges associated with minimum draught power. Initially the concept of planting basins was developed by Oldrieve (1993) in Zimbabwe and was subsequently modified and promoted in other African countries that include Zambia (Haggblade and Tembo, 2003). Temesgan (2015) is of the view that the practice of conservation farming is cost effective as a farmer does not need money, tractor, draught animals or special equipment to use the farming approach. The rationale is that planting basins can be prepared using a hand hoe and a string and the use of planting basins can work under every condition or situation in Africa (Lee and Thuerfelder, 2017). The use of planting basins is best suitable for areas that receive an annual average rainfall of 1000mm (Haggblade and Tembo, 2003).

According to Lee and Thierfelder (2017) the number of maize plants per hectare differs from country to country. In Lesotho for instance farmers strive for an average 35000 plants of maize per hectare. The implication is that they dig an average 17500 planting basins with a distance of about 75\*75cm (Lee and Thierfelder, 2017). Essentially, this means each planting basin will contain three maize seeds which are further thinned to two plants per basin (Temesgan, 2015). A study by Temesgan (2015) revealed that in Zambia farmers target an average 47000 plants of maize per hectare giving them about 15500 basins per hectare. In this case they put four seeds per basin which are then thinned to an average of three plants per basin.

The merits of using planting basins in conservation farming are that it is easy to make and use planting basins and these can easily be used by vulnerable groups that include the disabled and the elderly (Temesgan, 2015). The equipment needed to dig planting basins is readily available; this includes the use of hoes, strings, bottle caps and drink cans (Lee and Thierfelder, 2017). Thirdly the digging of basins can be done in advance soon after harvesting (Mazvimavi et al, 2010). This means that labour needs are spread over a long period of time as the digging of planting basins can be done earlier before the seeding season (Montt and Luu, 2018). The use of planting basins makes it easier to apply fertilizer as well as control weeds (Harfold and Breton 2009). The use of planting basins plays an important role in managing costs as they allow farmers to use the right amounts of seeds and fertilizer (Temesgan, 2015). The same planting basin can be used year after year from different crops and this lays fertile ground for improving the soil fertility, in the process promoting the ground for achieving great yields (Lee and Thierfelder, 2017).

It should however be noted that the use of planting basins also comes with its limitations that include the time needed to prepare the planting basins (Temesgan, 2015). Preparation of planting basins is time consuming particularly in the first year of adopting conservation farming (Mazvimavi et al., 2010). It becomes a major challenge in this instance when the soil is compacted especially for families that have limited labour or those families with members who are ill (Lee and Thierfelder, 2017). The development of the home care economy as a result of HIV and AIDS has made it difficult for families to successfully prepare planting basins in the where there is



limited labour in cases where family members are ill and in the time taken in caring for those who are ill (Temesgan, 2015).

**Table 2.2:Measuring of planting basins**

<b>How many basins?</b>		
<b>Rainfall (mm per year)</b>	<b>Spacing of basins</b>	<b>Number of basins per hectare (rounded off)</b>
> 1500	60 x 60 cm	27,500
1000–1500	70 x 70 cm	20,100
800–1000	75 x 75 cm	17,500
700–800	80 x 80 cm	15,500
600–700	85 x 85 cm	13,500
500–600	90 x 90 cm	12,500
< 500	100 x 100 cm	10,000

<b>How many seeds per basin?</b>		
<b>Crop</b>	<b>Number of seeds/basin</b>	<b>Planting depth</b>
Maize	2–4 (then thin one)	2.5 cm
Sunflower	2–3 at each end of the hole	2 cm
Cotton	4–5 on each side	1 cm
Soybeans	8–12	1 cm
Groundnuts	6–10	3 cm
Cowpeas	5–7	2.5 cm
Green gram	6–8	2 cm
Sorghum	8–12	1 cm

Source: Temesgan (2015:45)

### **2.7.3 Application of crop residues**

Mhlanga and Muoni (2014) argue that the use of crop residues in conservation farming has been shown to improve soil properties. The crop residues used by farmers may be taken from previous crops or imported into the field to achieve an average of 30% ground cover (Adekalu, 2017). In essence soon after harvesting during the dry season crop residues are smeared on the surface of the soil (Corbeels, 2015). The major advantage of the use of the crop residues is that mulch protects the soil from heat and weeds, in the process limiting soil evaporation and hence lays fertile ground for improving the fertility of the soil (Mhlanga and Muoni, 2014). Thierfelder and Wall (2008) contend that the value proposition brought about by crop residues is that they drive in the positive

realization of the benefits of conservation farming which include protecting the soil from the direct impact of rain drops that reduces soil erosion. Corbeels (2015) claims that the use of crop residues is essential in conservation farming as they are instrumental in decreasing run off and soil loss in areas that have low slopes. In a study conducted by Adekalu, Balogun and Aluko (2009) to assess the rationale of using crop residues in conservation farming, it was discovered that in order to increase water infiltration and reduce soil erosion there is need to ensure 90% cover of land by crop residues Cook and Anderson (2010) further add that crop residues have low thermal conductivity and thus play a role in reducing temperature providing a conducive environment for the optimal germination of crops as well as root germination in areas that are affected by hot temperatures. This indicates that crop residues are critical in areas affected by climate change as characterized by hot temperatures and erratic rainfalls. Zhang and Zhonghu (2015) are of the view that the use of crop residues is instrumental in improving the efficient use of water by an average 10-20% due to minimised soil evaporation and improved transpiration in plants.

Mhlanga and Muoni (2014) indicate that in the Zimbabwean smallholder farming sector there is low crop biomass and crop livestock interactions which results in crop residue management challenges in conservation farming. This creates competition on the use of crop residues resulting in challenges on the maximum utilisation of crop residues in conservation farming (Zhang and Zhonghu, 2015). One of the critical ways of preserving crop residues is through fencing fields that will reduce the chance of the crop residues being grazed by stray cattle during the cropping season (Jaleta, Kassie and Erensteina, 2015). Grazing of crop residues by cattle has thus served as a serious challenge affecting the practice of conservation farming among smallholder farmers in Zimbabwe. According to Palm, Blanco and Declerk (2014) the majority of smallholder farmers combine the use of crop and livestock farming and thus also use crop residues as food for their livestock. The use of fences by farmers to reduce access to the fields is important (Jaleta et al., 2015). However, it should be noted that smallholder farmers are in most cases resource constrained and hence it becomes a burden and serious challenge to access such management options (Mhlanga and Muoni, 2014). The solution to this challenge is for farmers to introduce non-crop residues that include thatch grass, this goes a long way in reducing competition for crop residues during dry seasons (Mhlanga, 2015). Jaleta et al. (2015) agree with Mhlanga and Muoni (2014) that

conservation farming is a challenge in areas where smallholder farmers practice mixed crop livestock systems and thus the need to reduce the demand for crop residues through the introduction of alternative feeding sources and provision of good extension services on the use of crop residues. The concept of mixed crop livestock systems raises a question on whether this type of farming approach is the cause for the low yields being experienced by farmers practicing conservation farming particularly in Zimbabwe despite the significant progress that conservation farming has made in improving farm yields in other areas (Palm et al., 2014).

#### **2.7.4 Application of manure**

The use of manure soon after land preparation is a critical element in conservation farming (Mazimavi et al., 2010). The recommendation is that farmers practicing conservation farming should make use of both organic and inorganic fertilizer to improve the fertility of the soil (Twomlow, 2014). Mukodzongi (2013) emphasizes that the application of manure is critical in enhancing system productivity, reducing runoff and in the process conserving soil moisture. Ghosh (2015) adds that the application of manure is aimed at increasing fertility within the planting basin for the crop. A study conducted by Mazimavi et al. (2010) revealed that in most instances smallholder farmers have limited knowledge and experience on the application of manure. This is noted through the way in which they generally tend to apply manure that will not have decomposed which has a potential of burning the crop particularly if the manure comes in contact with the seeds (Twomlow, 2014). Mazimavi et al. (2010) adds that the other challenge observed in the study on the application of manure is that of missing the timing of manure application. This is because smallholder farmers have a tendency to apply manure during the planting phase which increases the need for labour that is needed when one is practicing the use of conservation farming (Mazimavi et al., 2010). In addition, when application of manure is done at the same time as seeding, seed manure contact results and this negatively affects the germination of the seeds (Mukodzongi, 2013).

Ghosh (2015) argues that during dry spells the application of manure may also have a negative effect on crops which results in crops being burnt mainly in prolonged dry spells. This then brings

about the need for farmers to have knowledge and appreciation of how the application of manure works predominantly in terms of timing the application as well as understanding the quantities needed in each planting basin (Mazimavi et al., 2010). This shows the important need for farmers to be fully trained on conservation farming practices as this is instrumental in ensuring that farmers are equipped with the right skills and knowledge needed to make this farming method a success (Mukodzongi, 2013). This brought about the need to assess the extent to which smallholder farmers in Zimbabwe have the knowledge and skills on manure application as this has a bearing on agricultural productivity.

### **2.7.5 Crop rotation**

Florentin et al. (2010) conceptualized crop rotation as the variation of different crops that are cultivated on the same land cultivated following successive years. The ultimate aim of crop rotations is to contribute to the management of a production cycle that is profitable and sustainable, promotes soil fertility and increases food production (Sun et al., 2018). Mazimavi et al. (2010) posit that crop rotation is a key principle in conservation farming. The key benefit of rotating crops is that it enables the fertility of the soil to improve, reduces the chances of complete crop failure in times of famine and outbreaks of diseases (Marongwe et al., 2017). Kirkgaard (2016) posits that crop rotations are critical in conservation farming since weeds and diseases have a potential to thrive in the crop residues and in the process be transferred to another farming season if a similar crop is produced consecutively. Added to that, weeds have potential to become resistant to herbicides especially when they are used over and over again. Thus, by changing the crops, the diseases of one crop cannot build up to another (Gosh, 2015). Florentin, Penalva and Calejari (2013) add that the principles of crop rotation are in contrast to those of monoculture which rely on the cultivation of a similar crop year after year in the same place. Sloan et al. (2018) concur that the practice of monoculture is associated with various challenges that include increase in pests and diseases, proliferation of weeds, reduced yields, and increase in toxic substances in the soil together with reduced biological diversity. It is against this background that the practice of crop rotation in conservation farming is aimed at mitigating against the challenges associated with the use of monoculture (Kirkgaard, 2016).

In an experiment carried out by Florentin et al. (2013) which was aimed at assessing the effectiveness of using crop rotations, it was observed that low yields of peanuts, cassava and corn were obtained on farms where the same crop was repeated year after year. It is in this regard that the experiment concluded that it is imperative for farmers to abandon monoculture and adopt a more integrated system of crop rotations in the practice of conservation farming (Florentin et al., 2013). Marongwe et al. (2017) cite various opportunities that arise through the use of conservation farming. These include better control of pests and diseases on crops, better weed control, increase in crop yields, increase in soil fertility and improvement in the structure of the soil, thereby facilitating crop development. According to Corbeels (2015), when using crop rotation, it is critical to always use manure and cover crops to improve soil cover and organic matter. It is also essential to ensure that the same species of crops should never be sown in the same place the following year (Florentin et al., 2013). Crop rotations are thus viewed as the most economic and efficient means of breaking the cycles of diseases and pests hence making conservation agriculture feasible (Marongwe et al., 2013).

## **2.8 Factors affecting the adoption of conservation agriculture**

There are diverse factors agreed to by different scholars that are believed to be playing a substantial role in the adoption and rejection of conservation farming by communal farmers (Thierfelder and Wall, 2008). Haggblade and Tembo (2003) concur that there are instances at institutional level as well as farmer level that have resulted in the low adoption of conservation farming among farmers. Observations by Haggblade and Tembo (2003) revealed that in countries like Zambia, early non-governmental partners that pioneered for the adoption of conservation farming that include World Vision have stopped their drive to advocate the implementation of conservation farming despite investing in a number of experimental trials. The assumption by Thierfelder and Wall (2008) is that the institutional rejection is as a result of the need of a robust management system together with advanced skills required to successfully scale the effective implementation of conservation farming.

It is critical for one to appreciate that adequate and correct information on conservation farming needs to be disseminated to the public in order to promote the adoption of conservation farming (Mazimavi et al., 2010). Gukurume et al. (2010) assert that intense training is required and provision of herbicides and critical support resources needed to reduce the challenge of intensive labour. The argument is that without the critical support resources the use of conservation farming will continue to be shunned by the smallholder farmers and ultimately its valued goals will not be achieved (Gukurume et al., 2010). Knowler (2013) also observed that education is assumed to be associated with the adoption of conservation farming practices.

Knowler(2013) identified information as a factor that correlates to the adoption of conservation farming technology. The reasoning is that without adequate information on the use of conservation farming and its key principles it impossible for smallholder farmers to adopt the use of conservation farming (Harrera and Sain, 2009). To buttress this, Twomlow (2014) acknowledges the diffusion innovation theory that clarifies the importance of adequate information in providing an enabling environment for the adoption of an innovation. It is in this regard that different channels of passing information related to an innovation should be deliberated before introducing the innovation (Harrera and Sain, 2009).Agbamu (2012) posits that receiving information on its own will not be effective in motivating for the adoption of an innovation but the way in which the information is communicated will go a long way in determining if adoption of an innovation will take place.. Gukurume et al. (2010) argue that the problems related with the adoption of conservation farming demand for deliberate methods in the development agenda that are holistic in their approach of achieving food security and sustainable development. A critical lesson is that if the use of conservation farming managed to yield great results in Zambia it does not necessarily mean that the way in which it was implemented in Zambia will work the same way for Zimbabwe (Gukurume et al., 2010).Corbeels (2015) points out that, even though farmers that practice conservation farming tend to have a positive view, a lack of experiential knowledge hinders adoption. Derpsch and Friedrich (2010) concur that the key obstacles affecting the adoption of conservation farming among smallholder farmers need to be deeply investigated so as to achieve sustained growth. It is believed that conservation farming involves vigorous functioning of smallholder farmers' cognitive abilities calling the need for farmers to be rigorous in terms of

planning and commitment to continuous learning through trial and error. (Friedrich and Kassam, 2009). The realization is that when evidence based data on conservation farming is not accessible from recognized channels of support that include agricultural extension officers, peers or past experience, smallholder farmers may lack the incentive to adopt the use of conservation farming fully resulting in poor implementation of conservation farming systems (Corbeels, 2015).

Milder, Majaneni and Scherr (2011) observed that knowledge on conservation farming is not widespread around the African continent. This is because it is seldom taught, even in specialised agricultural training institutions. In instances where knowledge on conservation farming is shared, the information shared is often divorced from the realities of the local level land management systems. Milder et al.(2011) highlight that during trainings conservation farming is usually implemented in artificial land management systems that include experiment stations instead of taking the training directly to the farms where smallholder farmers may have ownership, which is critical in laying fertile ground for the adoption of conservation farming.

## **2.9 Gender and conservation farming**

Harford and Britton (2009) are of the view that the practice of conservation farming affects men and women differently. This has a role to play in affecting the effectiveness and adoption rate of conservation farming between men and women bearing in mind the differences in gender roles (NORAD, 2011). Milder et al. (2011) agree that there is recognition that different farming approaches affect men and women in unique ways thus the need to analyse how gender roles affect both men and women in terms of adopting the practice of conservation farming. March, Smith and Mukhopadhyay (1999) point out that there are two commonly used gender analysis frameworks that include the Harvard analytical approach and the women empowerment framework that recognize and emphasize the existence of differences in gender roles that may affect development initiatives. According to DIFD (2015), the Harvard Analytical Framework in its activity profile illuminates how gender roles with regard to productive and reproductive work affect men and women differently in the context of household and community roles. Similarly the Women Empowerment Framework notes in its concept of the women's special needs that, women have

different needs to those of men, and the differences in these needs goes on to deeply affect gender roles which in most instances leaves women with the heavy labour burden (March et al., 1999). The assumption from the two frameworks is that gender gaps exist due to the division of gender roles which perpetuate inequalities in the quantity of work that women have to engage in (March et al., 1999). It is in this regard that the study sought to understand if gender division of labour had an effect in the adoption and maximum utilisation of conservation farming. This was instrumental towards the development of a prototype for implementing conservation farming that recognises the different needs of men and women.

NORAD (2011) observed that in most of the farms across Africa, the responsibility of the preparation of the land and weeding lies with the women whilst the responsibility of marketing the produce lies with the men. Milder et al. (2011) note that conservation farming can go a long way in perpetuating inequalities in gender roles between men and women. Thus the labour burden immensely increases for women as they are required to engage in activities that include the digging of planting basins and the removal of weeds and at the same time expected to attend to their reproductive roles (NORAD, 2011). Niang, Rappel and Abdrabo (2011) argue that when women are burdened with the demands to labour they may be discouraged from adopting the use of conservation farming to a point where eventually even when labour demands decline in the long-term they may not be in a position to adopt the use of conservation farming. Hence it is critical to understand how the effects of conservation farming in Zimbabwe affect men and women differently.

Milder et al. (2011) note that in Africa, women often take a central position in the decision to adopt conservation farming because they tend to be more actively involved in small-scale farming than men. Mloza-Banda and Nanthmabwe (2010) give an example of Malawi where the proportion of women adopting the use of conservation farming was 14% higher than that of men. NORAD (2011) posit that despite the potential for the adoption of conservation farming across various African countries, there are still some noteworthy obstacles to the adoption of conservation farming by women emanating from traditional patriarchal gender roles. Niang et al. (2011)



highlight that unequal opportunities in terms of access to credit, inputs, education and land are also significant barriers for the adoption of conservation farming by women in Africa.

## **2.10 Conservation farming: the green revolution**

Cunningham (2016) posits that the green revolution was a time when the growth of agriculture was influenced by new advances. The concept of the green revolution is underpinned by the need for agriculture to shift from the conventional way of doing things. This entails an approach that will see agriculture adopting new and innovative ways that play a crucial role in increasing agricultural productivity more than ever before (Mkomwa, 2013). In this instance, conservation farming has been epitomized as one of the drivers of the new green revolution that seeks to improve agricultural productivity in view of the current challenges presented to smallholder farmers by the realities of climate change.

CIMYT (2015) is of the view that Africa has not benefited much from the green revolution when compared to Asia due to the fact that the African continent is faced with infrastructure problems as well as farmer inability to access loans from banks due to tenure right issues. In order for Africa to benefit from the green revolution, smallholder farmers have to adopt conservation farming which will play a critical role in improving soil fertility and agricultural productivity (Mkomwa, 2013). The assumption is that conservation farming is a more affordable method than investing in irrigation systems (CIMYT, 2015). Mkomwa (2013) posits that conservation farming is the foundation for Africa's green revolution. The consensus by Mkomwa (2013) and Findlater (2015) is that the global population will increase by 50% whilst that of Africa will increase by 150%. The African population will increase yet Africa's per capita food production has experienced a decline over the past 50 years. Given that Africa is a net importer of food (Rakatoaria, Laffate and Pachalim, 2011), conservation farming is seen as the panacea towards taking Africa through the new green revolution.

## **2.11 Artificial intelligence and agriculture**

When analysing the effects of conservation farming, it is essential to appreciate the future of farming with regard to the role that technology plays as an enabler in solving the challenges faced in the agricultural sector. Global trends have shown countries adopting technology as part of their strategies of enhancing the effectiveness of conservation farming (Sennar, 2017). Artificial intelligence and machine learning is considered as part of the solutions towards improving conservation farming and ultimately agricultural productivity in view of the current challenges being faced as a result of climate change (Herweijer and Waughray, 2018)). According to Sennar (2017) artificial intelligence and machines have an instrumental role to play in three major categories. These are

- (a) Agricultural robots - the argument is that companies are now taking an active role in the development of robots that will take a deliberate role in carrying out critical tasks such as harvesting, digging of basins, seeding and the management of weeds (FAO, 2017). The challenge of weeds in conservation farming is a topical issue today (Twomlow, 2014). An evaluation carried out in America by the weed society noted that there is a projected stwo hundred and fifty species of weeds that have been resistant to herbicides posing a serious challenge for farmers and this has resulted in farmers loosing over \$43 billion annually (Sennar, 2017). FAO (2017) posit that this has promoted the rise of companies that are taking a serious role in developing robots to help farmers find more effective and efficient means of protecting their crops from weeds. Today a robot named See and Spray has been developed by the Blue River Technology Company (Sennar, 2017). Sennar (2017) confirms that the robot focuses on monitoring and precisely spraying weeds on plants. According to FAO (2017), in the United States of America the use of robots in precision spraying eliminates 80% of the volumes of herbicides that are normally sprayed to fight weeds and this brings a saving of an estimated one billion pounds that are used annually. The use of automation in the agriculture industry is estimated to reduce the agricultural

labour force by six percent between the years 2014-2024 (Sennar, 2017). This comes in as an effort to address the labour challenges faced by farmers using conservation farming (Twomlow, 2014). FAO (2017) claims that in just one day a robot can harvest an average eight acres and in the process replace thirty farm labourers.

- (b) Crop and soil monitoring - the logic is that technological innovations that are leveraging on deep learning algorithms and computer vision to process information captured by drones have a fundamental part in the monitoring of crops and the soil (Sayler, 2015). Soil degradation and erosion are a major challenge affecting farmers and remain a significant threat to food security (Corsi, 2011). Sennar (2017) notes that in Berlin an agricultural technology start-up called Planitx was set up. This start up works on identifying defects and nutrient deficiencies in the soil (Sennar, 2017). This is a process that is done through a software algorithm which correlates soil defects, pests and diseases and provides solutions for restoring the defects. According to Sayler (2015) a smart phone can be used where the farmer captures an image of the soil or crop and then identifies the challenges and the solutions to what is observed. This form of technology is thus making it easy for farmers to identify various challenges that are affecting their crops as well as the solutions to the challenges (Sayler, 2015). The use of drones in the analysis of crops is also emerging as an important tool to support farmers (Leica, 2017). The cost in the demand for drones in farming is expected to get to four hundred and eight million by the year 2027 (Sennar, 2017). This is based on the belief that there is now reliance on leveraging on artificial intelligence and aerial technology to monitor crop health (Sayler, 2015). According to Leica (2017) Sky Squirrel Technologies, a start-up based in Japan that focuses on capturing data from a drone then use algorithms to analyse the captured data and provide a detailed report to farmers, posits that this type of technology is able to survey an average of fifty acres of land in twenty four minutes and in the process provide an analysis of the data with a confidence level of 95% accuracy. The study was concerned with establishing if farmers practicing conservation farming in Zimbabwe have the knowledge of this technology that is critical in helping achieve sustainability in the practice of conservation farming in a

world that is fast changing. This was critical in understanding the effects of conservation farming in Zimbabwe.

- (c) Predictive analysis - This is based on the concept that models on machine learning are being advanced to monitor and forecast threats that include weather pattern changes in the environment that can negatively affect crop yields (Sayler, 2015). Sennar (2017) explains that aWhere, a start-up in Colorado, harnesses machine learning algorithms in association with satellites to forecast weather patterns and analyse the ability of crops to thrive. This is a technology that has been established in the backdrop of the challenges associated with climate change. According to Herweijer and Waughray (2018), climate change weather patterns are unreliable and inconsistent and this puts a heavy burden on farmers when their crops are unable to stand certain weather conditions.

Herweijer and Waughray (2018) posit that although artificial intelligence has a role to play in assisting farmers through solving the various challenges that they experience, if left unguided, artificial intelligence has the potential to accelerate environmental degradation. This brings about the need for what Herweijer and Waughray (2018) have termed a value aligned safe artificial intelligence future aligned with human values complementing a safe and friendly technology for human kind. It is key for smallholder farmers in developing countries that include Zimbabwe to understand that as the world moves to the fourth revolution there is need to adopt innovative approaches and to complement the current approaches of conservation farming that aim to improve agricultural productivity and ultimately sustain the livelihoods of smallholder farmers in view of the current vagaries of climate change and variability that are affecting smallholder farmers (FAO, 2017).

## **2.12 Agricultural productivity**

Crop yield per hectare which entails the amount of crop that is harvested versus the amount of land planted is the widely used measurement for agricultural productivity (Diskin, 2000). Agricultural productivity assesses the total agricultural yield that is produced against the size of land (Zikhali,

2008). Thus for the purpose of this research, the study analysed the effectiveness of `conservation farming through calculating the amount of crop that is harvested against the `amount of land planted for both the control group which consists of post 2000 land reform programme farmers making use of the conventional farming method and the treatment group which consists of farmers practicing the conservation farming method. This was critical in finding out whether the use of conservation farming has been statistically significant in increasing agricultural productivity. The research thus focused on this key indicator in the agricultural productivity indicator that analysed harvested crop yield per hectare against the total area of land planted.

The state has an important role to play in supporting agricultural productivity. However a serious challenge that arises with respect to state assistance relates to the unequal opportunities to access resources between commercial and smallholder farmers which in turn affects agricultural productivity (Moyo, 2014). Zikhali (2008) is of the view that the government gives commercial farmers preferential treatment when it comes to farm inputs, with the government channelling seeds and fertilizers to commercially resettled farmers overlooking smallholder farmers since the commercial farmers are an asset to the government's efforts of keeping the Grain Marketing Board afloat and functioning. The understanding is that the state invests in commercial farmers for reasons of return on investment and fulfilling the dream of the Third Chimurenga yet neglecting the smallholder farmers (Batasara, 2015). As a result of these variations in opportunities to access inputs, the study focused on making comparisons among smallholder farmers only without any particular reference to the large scale commercial farmers with the aim to develop solutions that will be vital in empowering smallholder farmers. It is against this background that agricultural productivity was assessed through analysing the area of land planted versus the area of land harvested with a particular focus on smallholder farmers in Zimbabwe.

**Table2.3:Generic agricultural productivity performance indicator**

Indicator	Data Needed for Measurement	Data on Causal Factors	Measurement Methods	Calculation	Units	Concerns/Issues
1. Harvested crop yields per hectare	Harvested output Area planted	Farm practices Rainfall	Farmer survey Area measurement Rain gauges	Output/area (with reference to rainfall)	Kgs. per hectare	Farmer estimate vs. cropcut Inter- and multiple cropping Economic considerations
2. Gap between actual and potential yields	Harvested output Area planted Demo plot yields	Farm practices Rainfall	Actual (as above) Potential- complete demo plot harvests	$(1 - \text{actual/potential}) \times 100\%$	Percent	Harvest yield potential vs. economic maximization ("economic yield gap")
3. Yield variability under varying conditions	Yield time series (pre- and post-activity)	Farm practices Rainfall time series	Methods must be consistent with pre-activity methods	Range or standard deviation. (see Chapter 4.3)	Kgs. per hectare	Difficulty in having consistently collected pre- and post-activity data
4. Value of crop production per household	Harvested output Income from sales Input costs Month stocks run out Prices/inflation rate	Farm practices Rainfall	Farmer survey Market prices (if possible secondary) Rain gauges	$(\text{Sales income} + \text{monthly cons.} \times \text{prices-inputs}) / (1 + \text{inflation rate})$	(Inflation-adjusted) units of money	Different transaction levels Price seasonality/inflation Non-marketed crops Valuing crop by-products Labor costs
5. Months of household food provisions	Month of harvest Month stocks run out Month last tuber harvested	Farm practices Rainfall	Farmer survey Rain gauges	Time between harvest and stock depletion	Number of months	Crop sales, nonfarm income and market food purchases
6. Percent of crop losses during storage	Amount crop stored Amount of crop lost Time in storage	Storage practices Number storage facilities built	Farmer survey Counting/weighing (demo. plots)	Loss rate per time period x amount stored	Percent	Losses in nutrition/quality Differences between demo facilities and actual
7. No. of hectares (or hhs.) with improved practices	List of practices Area (or # of hhs) where practices used	(none)	Farmer survey Area measurement (optional)	(none)	Number hectares or hhs	Partial applications of improved practices
8. Number of crop storage facilities built and used	Number facilities built Number facilities used	(none)	Farmer surveys Project records	(none)	Number of facilities	Volume of facilities Quality of facilities

Source: Diskin (1997:3)

## 2.13 Types of land reform

Wolford (2005) defined land reform as the reallocation and movement of property rights of land from the elite class to the minority poor. Moyo (2008) adds that land reform aims at bringing about

an equitable distribution of land and the political power emanating from it. There are three common types of land reforms that have been implemented and these include restitution type of land reform, tenure reform and redistributive type of land reform (Scoones, 2009). Focus on this research was on the redistributive type of land reform which aims to rectify inequalities in land distribution patterns by way of state intervention in the market process. Redistributive land reform targets individuals who did not have land before and thus aims at cheap and speedy delivery of land for agricultural purposes (Scoones et al., 2011). The post 2000 land reform implemented in Zimbabwean widely referred to as the fast track land reform is a type of redistributive land reform that was implemented with the objective of closing the gap in terms of access to land between the whites and the blacks (Zikhali, 2009). The research focused on the redistributive type of land reform in analysing the effects of conservation farming in Zimbabwe as this was the major land reform programme in Zimbabwe that massively altered the agrarian structure.

#### **2.14 Climate change the force behind the adoption of conservation farming**

Gukurume et al. (2010) argue that climate change is an important subject affecting agricultural productivity resulting in food insecurity. Brazier (2015) is of the view that there is consensus that climate change and variability will affect everyone in this globe, this is because of its role in affecting food and water security hence reshaping the natural world from what it has known it to be. Brown et al. (2012) argue that the socio economic conditions and the livelihood strategies of the underprivileged in Zimbabwe are heavily vulnerable because of their solid dependence on rain fed farming.

According to Dube (2015), the influence of climate change has necessitated the need for farmers to develop mitigation strategies to fight the harsh outcomes of famine. Climate change is conceptualized as the substantial weather changes that occur over a long period of time (Gukurume et al., 2012). Brazier (2015) agrees with Gukurume et al. (2012) by defining climate change as the gradual changes in the global climate emanating from the release of greenhouse gases that include carbon dioxide and methane resulting in the planet becoming hotter. Khalibatha (2017) argues that

although Africa produces less than three percent of the climate change inducing greenhouse gases, as such it will suffer more in comparison to other continents. In the Zimbabwean context, climate change realities will result in the average temperature increasing by a typical 3°C before the end of this century (Brazier, 2015). This will result in rainfall variability, leading to increase in droughts, storms and floods in the process propelling serious food insecurity challenges for the nation (Dube, 2015). Brown et al. (2012) posit that high temperatures and the prevalence of rainfall variability as a result of climate change are expected to exacerbate declining agricultural outputs in the process posing as a stumbling block to economic growth, food security and poverty reduction. This then brings about the need for a holistic approach in addressing the challenges being brought about by the negative realities of climate change (Ndlovu and Mpofu, 2016).

Nkala (2015) highlights that concerns have been raised that climate change has brought about significant challenges in the agricultural sector. According to Dube (2016), Zimbabwe has experienced variations in rainfall patterns over the past century and this has resulted in average rainfall patterns declining due to climate change. It is now common for the country to experience four to five dry spells during an average rainy season and this presents a challenge for the country (Moyo, 2008). It is against this background that it is projected that the changes in the climate will aggravate suffering and poverty for the people in Zimbabwe (Dube, 2016). Gukurume (2016) notes that food insecurity and famine in various developing countries has been attributed to the decline in agricultural productivity owing to climate change. Climate change in Zimbabwe has conveyed itself in the form of reduced rainfall patterns and incidence of high temperatures (Ndlovu and Mpofu, 2016). Doodman and Mitlin (2014) are of the view that universal food security is expected to be endangered by the pressures resulting from the negative outcomes of climate change. The implication to this reality is the disruption of major staple foods such as maize, rice and wheat (Doodman and Mitlin, 2014). Brown et al. (2012) explain that if climate change continues to persist then it must be appreciated that conventional agricultural systems will become more and more unsustainable.

Dube (2015) argues that if no climate change adaptation measures are taken yields with a dependence on rain fed farming have been predicted to decline by up to 50% by the year 2020.



Khalibata (2017) adds that there is urgent need for Africa to challenge the problem of climate change more than anywhere else in the world since 70% of the population in Africa relies on rain fed smallholder agriculture. The crop that is mostly going to be affected is maize due to its intolerance to droughts which then propels the exacerbation of food insecurity in years in which farmers experience prolonged and frequent droughts (Brown et al., 2012). Ultimately, it is projected that sub Saharan Africa will experience losses in agriculture which account for 2-5% of the gross domestic product (Chakwana, 2015). It is in this regard that conservation farming has been accepted as the remedy that seeks to improve agricultural productivity in areas that are depressingly affected by climate change (Gukurume, 2016). This underscores the deliberate focus of this research to assess the effects of conservation farming with the ultimate aim of increasing the agricultural productivity.

Brazier (2015) notes that in a case study that was piloted in Muzarabani, a district found in Zimbabwe northern of Mozambique, it was observed that the district is characterized by high temperatures which have led to floods and droughts being a common phenomenon in the district. Interviews with the local farmers revealed that the climate in the district is characterized by shorter growing seasons exacerbated by the increasing dry weather conditions (Brazier, 2015). In a bid to survive the negative outcomes of climate change the community is now relying on indigenous knowledge systems that comprise social safety nets such as the chief's granary, wild fruit harvesting, dry planting, planting famine tolerant crops such as the small grains and the practice of conservation farming (Brazier, 2015). It is evident that climate change is already negatively affecting the people of Zimbabwe particularly the smallholder farmers hence the need to find lasting sustainable solutions to improve crop productivity and become resilient to the negative effects of climate change (Dube, 2015).

#### **2.14.1 Climate change response strategy**

Konrad (2015) posits that climate change presents a fundamental threat to sustainable development with its impacts affecting those who are poor. The Paris Agreement, the Sendai Framework for Disaster Reduction and the Sustainable Development Agenda 2030 provide the cornerstone for

sustainable low carbon and resilient development under a climate that is continuously changing (Bonn, 2018). The sustainable development goal number 13 recognizes the urgent need for fighting climate change through taking deliberate controls to fight its outcomes (UN, 2018). The sustainable development goals provide a globally shared vision of a better world by the year 2030 (UN, 2018). Sustainable Development Goal 13 targets to reinforce resilience and climate change adaptability to related threats and natural disasters in all countries. According to the UN (2018), the goal also seeks to merge the actions that have been taken to fight climate change with national policy guidelines and plans. Thirdly the goal takes priority in enhancing awareness on climate change education and in strengthening institutional capabilities in dealing and leaving with climate change (UN, 2018). Finally the goal seeks to execute the obligation accepted by first world countries on the climate change agenda pioneered by the United Nations through making a commitment of collaborating and mobilizing one hundred billion dollars yearly by 2020 from various partners to deal with the challenges that third world countries face in the quest of building resilience towards the outcomes of climate change (UN, 2018). According to the UN (2018), the Paris Agreement presents a collaboration of various nations who are united in a common cause to support the world's reaction to climate change through maintaining a global response temperature growth to beneath two degrees Celsius and limiting the increase of temperatures to an average of between one and five degrees Celsius. The Paris Agreement further seeks to increase the capacity of countries to challenge the negative outcomes of climate change (UN, 2018). Meeting the objectives of the Paris Agreement requires a supporting model of technology, adequate cash flows and full support from developed countries to the vulnerable countries (UN, 2018).

The Sendai Framework on Disaster Risk Management presents one of the major agreement of the post 2015 development agenda that recognizes the necessity to fight climate change considering its role as a threat to disaster risk management while also appreciating the role of the United Nations agenda and resolution on climate change (UNDRR, 2017). Zimbabwe signed and ratified the United Nations Framework Convention on Climate Change (UN, 2018). According to GOZ (2015), upon realizing how climate change was negatively affecting agricultural productivity resulting in food insecurity, the government of Zimbabwe developed a plan of action as a reaction to the challenges of climate change .The intention of the plan of action was to strengthen the

capacity of farmers through generating innovative ideas to support agriculture (GOZ, 2015). The Zimbabwe national response strategy to climate change acknowledges that climate change is the principal danger to humanity today; however, this is the opportunity for researchers and policy makers to rise to the challenge to make this world a better place to live (GOZ, 2015). Conservation farming is noted as one of the strategies adopted to deal with the negative effects of climate change though in some cases it has been condemned for being unfriendly to vulnerable groups as it requires a lot of labour (Gukurume, 2016). It is against this context that this research sought to establish whether farmers were properly trained on how to use the conservation farming method and whether farmers were provided with the appropriate technology needed to fully implement conservation farming

## **2.15 Synthesis of Literature**

A review of literature on studies that have been done to identify variables that affect the effectiveness of conservation farming across North America, Africa and Europe is presented in this section. The three continents have been identified because of the rapid expansion of conservation farming in North America and Africa as well as the slow adoption of conservation farming in Europe (Kertesz and Madarasz 2014). In a study conducted in Bajio, Mexico by Cruz, Almekinders and Camacho-Villa (2019) to assess the critical factors that affect the implementation of effective conservation farming systems, results revealed that it is critical for those advocating for the implementation of conservation farming systems to embark on a campaign to ensure that smallholder farmers access knowledge on how the use of conservation farming is vital in increasing agricultural productivity. Cruz et al. (2019) argue that giving smallholder farmers knowledge on the implementation of conservation farming systems and on how making use of conservation farming may increase agricultural productivity should empower smallholder farmers to examine the ability of conservation farming in increasing agricultural productivity. The study revealed that when smallholder farmers examine the potential of conservation farming in increasing agricultural productivity factors such as the cost of implementing conservation farming

systems against the harvest that may be achieved are established. The study by Cruz et al. (2019) thus underscored the important need for smallholder farmers to be given information related to the benefits of the use of conservation farming in increasing crop yields. In as much as smallholder farmers are given knowledge on how the use of conservation farming may increase agricultural productivity, it is important for the farmers to also understand that a farming approach despite its potential to increase crop yields may have negative outcomes which in most cases are not anticipated. It is also imperative that those advocating for the implementation of conservation farming should reflect on the knowledge that smallholder farmers need to possess in order to adopt the farming approach (Cruz et al 2019). The study in Mexico recognizes the important role that knowledge plays in helping smallholder farmers implement effective conservation farming systems.

Another study conducted by Benton (2016) in Mexico revealed that three important arguments dominate around the implementation of conservation farming systems, these include appreciating that one size does not fit all, that is to say what may work in another area may not necessarily work in another area. The second argument is that solely utilising conservation farming as a technology is not sufficient to solve the challenge of food insecurity (Benton, 2016). Thirdly, it is critical to understand the importance of the local environment in which conservation farming is implemented as this is vital in reducing unintended outcomes that may arise without defining the local context (Benton, 2016).

In a study carried out by Wekesh, Mutua and Izigbara (2019) in Sub Saharan Africa, results revealed the need to review conservation farming through a gender eye. This was based on the premise that past approaches have often promoted the use of conservation farming neglecting the role that gender plays in affecting the effective implementation of innovative agricultural systems. Whitefield (2015) contends that it is important to understand how gender dynamics affect and influence agricultural systems. The study by Wekesh et al. (2019) established that male headed households had a greater chance of adopting the use of conservation farming in contrast to the female headed households in Sub Saharan African countries that include Zimbabwe and Zambia. The understanding was that male headed households had better access to land, finances and other

inputs. The implication by the study is that the male headed households have a greater potential of accessing the key capitals underpinning the sustainable livelihoods approach that are important in helping smallholder farmers implement conservation farming systems and overcome challenges that may arise along the way. A study carried out in Malawi by Ward, Droppleman and Benton (2018) revealed that the adoption of conservation farming is higher among households headed by males but with more females. The study by Ward et al. (2018) indicated that the use of conservation farming was higher among male headed households with more women because of the stereotypical nature of the patriarchal system that views women as cheap labour.

Through a study conducted in East Africa by Farnworth, Baudrn, Anderson, Misiko, Badstue and Stirling (2016) that sought to understand the decision making gender dynamics in the adoption of conservation farming, results revealed that decisions related to the adoption of conservation farming were mostly done by men. The study was conducted in Kenya and uncovered that female headed households were less likely to adopt the use of conservation farming in contrast to the male headed households. This was attributed to the patriarchal system that constrains women from realizing their full potential. The results from the study show the influence that gender roles play in affecting the adoption of conservation farming hence making it critical for the research to assess the role that gender plays in affecting the adoption and maximum utilization of conservation farming.

Ayuke, Kihara, Ayaga and Micheni (2019) conducted a study in Kenya to assess variables that need to be taken into consideration in the implementation of conservation farming systems. The study by Ayuke et al. (2019) pointed out the need for those who are promoting the use of conservation farming to gather evidence on sustainability indicators which include soil biological indices that can play a role in increasing agricultural productivity and in the process encourage smallholder farmers to adopt the use of conservation farming. The argument is that studies on conservation farming have often focused on assessing the socio economic conditions that promote the adoption of conservation farming neglecting an assessment of the soil biological indices that have a role to play in improving agricultural productivity and in the process influencing the adoption of conservation farming. The study conducted in Kenya by Ayuke et al. (2019) revealed

that the use of conservation farming was effective in enhancing soil macro fauna taxonomic richness and the abundance of mesofauna than did the conventional method of farming. The study thus recommended the need to capitalize on crop rotations and make use of mixed cropping in situations where crop rotations may not be effective as this is instrumental in promoting soil fauna diversity and abundance (Ayuke et al, 2019). The study further recommended the need for the addition of long term organic residues on the soil as this was important in promoting the development of soil fauna diversity and abundance (Ayuke et al 2019). Soil fauna is critical for the retention, breakdown and incorporation of plant remains, nutrient cycling and has an influence in the maintenance of soil physical structure (Merciris, Imbert, Reversat, Ponge and Lavelle, 2010). A good soil structure is critical as it allows air and water into the soil which is an important variable for healthy plant growth and ultimately laying fertile ground for the increase in agricultural productivity (Ayuke et al 2019).

Corsi (2019) argues that it is important to empower smallholder farmers to take an active role in scaling agricultural production systems that harness on the benefits provided by ecosystems and to build regenerative agro ecosystems. In a study conducted in Eastern Europe, results revealed that implementing effective conservation farming systems requires the building of multidisciplinary scientific and technical capacity as well as harnessing on close collaboration with farming communities as opposed to just engaging smallholder farmers as this is vital in capitalizing on their traditional knowledge systems.

The synthesis of literature across North America, Africa and Europe has shown that researchers focusing on the implementation of effective conservation farming systems have often concentrated on different variables that have to be taken into consideration in the implementation of conservation farming. This research took a holistic approach in combining the topical variables that researchers have often examined in silos. This was critical because of the appreciation that the different variables have an important role to play in strengthening the effectiveness of conservation farming systems when viewed as a whole. The key variables that have emerged through the synthesis of literature across the different regions noted in this study include the importance of knowledge. It is critical for smallholder farmers to have knowledge on the implementation of

conservation farming systems and this knowledge is not only limited to the appreciation of the positive results of making use of conservation farming but also extends to appreciating the negative outcomes that may arise through the implementation of conservation farming systems (Cruz et al, 2019). This triggered the need for the study to assess the extent to which smallholder farmers have full knowledge on the implementation of conservation farming systems; this was done through assessing the nature of conservation farming being implemented in Umguza District. Through the focus group discussions, the study, also sought to establish if smallholder farmers were aware of the negative outcomes of making use of conservation farming which entailed establishing if smallholder farmers were equipped with capitals to handle the negative outcomes that may arise through the use of conservation farming.

A key variable that has been identified in the gathered literature across the globe is that of the need to localize the implementation of conservation farming principles. Benton (2016) argues that there are remarkable differences between communities across the globe and hence the implementation of conservation farming systems may not take a one size fit approach. This view stresses the need for those advocating for the implementation of conservation farming systems to consider the unique contexts of different communities as they implement conservation farming systems. The study by Brenton (2016) also confirmed that the use of conservation farming should not be viewed as a panacea on its own but should be considered in the context of how other factors divergent from conservation farming principles can be used to improve agricultural productivity. The argument is that conservation farming alone may not be in a position of improve agricultural productivity. It is against this background that the research sought to understand whether the principles underpinning the use of conservation farming systems were applicable to the community in Umguza District. This was critical in the development of a prototype model of conservation farming that takes into account the unique context of smallholder farmers hence prompting the study to make use of the participatory approach through design thinking. The study also assessed other key components in agriculture that can be used to complement conservation farming in improving agricultural productivity.

Gender has also been identified as a variable that has an important role to play in affecting the effective implementation of conservation farming systems. Wekesh et al. (2019) acknowledge the important role that gender as a social construct plays in affecting the decision to adopt the use of conservation farming. Studies that have been conducted across Sub Saharan African countries and East African countries confirm that male headed households are most likely to adopt the use of conservation farming (Farnworth et al., 2016). It is in this regard that the study made a deliberate attempt to assess the extent to which female smallholder farmers are making use of conservation farming. This entailed making sure that female smallholder farmers are included in the sample of farmers selected for the study. An assessment of the role played by gender in affecting the effectiveness of conservation farming was also done through cross tabulating gender and increase in agricultural productivity.

Another important variable identified through synthesizing literature of various studies conducted is that of assessing the biological indices of the soil. The study conducted by Ayuke et al. (2019) confirmed that researchers that have analysed the effectiveness of conservation farming have often focused on the socio economic and political determinants of conservation farming neglecting the important role that assessments and understanding of soil biological indices play in strengthening the effectiveness of conservation farming. The implication for the study was to assess the extent to which smallholder farmers have knowledge on how soil fauna diversity and abundance has a part to play in promoting the effectiveness of conservation farming. It was also critical to establish whether smallholder farmers have awareness on practices that can be used to improve soil structure which is vital for enhancing the effectiveness of conservation farming as well as improving agricultural productivity.

## **2.16 Theoretical framework**

This part examines the theories that guided this study through analysing the tenets of the theories on participation, sustainable livelihoods, new institutional economies and diffusion of innovations. The critical objective of the study was to assess the effectiveness of conservation farming in improving agricultural productivity in Zimbabwe. The major principles guiding each of the



theories were used to guide the study in preparing the research design, data collection tools and the analysis of the data gathered.

### **2.16.1 Participation**

Participation is conceptualised as a practice by which stakeholders especially the poor are empowered to determine and regulate development interventions with the capacity to make decisions on issues that affect them (World Bank, 2011). According to Myles (1996) when local people participate in development programs, it is hoped that they will articulate and identify their problems and will be better able to find lasting solutions to the challenges they face. Cummins and Coventry (2009) argue that, participation is an instrumental method in developing and implementing any farming culture and is one that should guide farmers as they develop their farming systems. According to Reed and Stringer (2016), there is realization that environmental challenges that include climate change cannot be tackled in isolation hence the need for engagement with different stakeholders who have different and conflicting priorities which is critical in solving the challenges faced by communities.

It has been agreed that participatory approaches to solving environmental challenges that include climate change have the ability to decrease conflict, shape confidence and promote learning among various stakeholders which is critical in finding lasting and sustainable solutions to the challenges faced by developing countries (Cummins and Coventry, 2009). Creasy (2007) adds that by empowering individuals to make decisions on issues that affect them, participation will play a vital role in strengthening accountability and ownership empowering the community to address their challenges. Claridge (2004) coined the term participation democratic experimentalism which aspires to involve citizens and associations by listening to their voices and using their abilities and knowledge within policy making, planning and service implementation. Bifulco (2008) argues that participation which is now being regarded as an inclusive technology necessitated by governance seeks to empower citizens and emancipate them from the passive role of being mere targets of policies. In order for research related to agricultural productivity to be of benefit to the rural poor and smallholder farmers, research should focus on a bottom up approach taking advantage of

resources that are already available that include local people, their knowledge and their natural capital putting into consideration the desires and aspirations of the smallholder farmers (Altieri, 2005).

Isgren (2012) claims that it has become apparent that bottom up participatory approaches based on indigenous or local farmer's knowledge lay fertile ground for greater uptake of innovative technologies. Isgren (2012) agrees with Altieri and Nicholas (2005) that harnessing farmers' local knowledge and skills is a prerequisite for the development of sustainable agriculture. Cummins and Coventry (2009) add that by allowing farmers to participate in coming up with new practices, utilizing participatory approaches helps to empower farmers to develop an improved appreciation of agronomic techniques which is instrumental in identifying the challenges they face and the ways of overcoming those challenges. Harfold and Breton (2009) agree that one should use participatory methods which permit societies to come up with answers to their own needs. Thus the concept of participation denotes farmers as active beings who should take an active role in determining the type of farming approach adopted (Reed and Stringer 2016). The question to be answered was whether farmers in Zimbabwe were involved in the resolution to adopt conservation farming as a means of improving agricultural productivity against the negative effects of climate change. This participatory approach enabled the researcher to identify the reasons why conservation farming is failing to increase agricultural productivity. The theory guided the researcher in assessing whether conservation farming is a top-down approach imposed to farmers or it is participatory in nature. The participatory approach helped the researcher to establish the impact of conservation farming in promoting agricultural productivity and in addressing food insecurity challenges. This entailed taking a vigorous role in actively involving the smallholder farmers in analysing the effectiveness of conservation farming. The implication to the study was the adoption of participatory approaches to data collection that include the use of transect walks.

It should however be noted that the participation theory has been subjected to numerous criticisms. Mohan (2008) writes that participation can be described as rhetoric. This is based on the assumption that the use of participation in the development discourse has become vulnerable to the belief that participation is a desirable goal in itself resulting to what Parkison (2009) terms the

doctrine of maximum participation. Isgren (2012) cites various challenges associated with the use of participation that include costs such as time and effort that comes with the use of this approach particularly in situations where participants may not be able or willing to pay. Knowler (2011) notes that in a survey conducted in Scotland, it was observed that the chances of smallholder farmers participating in conservation farming were higher as long as there was a perfect match with the farm context and the costs of implementation were minimal. It is in this regard that the study ensured that farmers do not incur monetary costs when data was being collected. The researcher explained the importance and benefits of the research to the farmers. This was critical in ensuring that farmers find value in dedicating their time in providing information and participating in the research. Sanginga et al. (2006) found out that in a study carried out in Uganda on soil fertility, farmers dropped out of the study after the initial phase when it became clear to them that there were no free hand outs or benefits for them to participate in the study. Hence for this reason it was imperative that the benefits of taking part in the research be clearly outlined to the farmers.

Mohan (2008) argues that participation has been criticized for treating participants involved as a homogeneous group failing to recognize gaps between the local elite and those that are marginalized. Greiner (2012) posits that aspects of gender in relation to agricultural research are often ignored in the process failing to understand that agricultural development in most cases involves the transfer of technology which is not a gender neutral process. Humphries et al. (2014) explain that various studies on farmer research in different parts of the world have tended to under represent women. The reasons behind the exclusion of women is due to the multiple roles that women have that often disadvantage them, increasing their work burden and limiting their chances of accessing education (Mohan, 2008). The researcher thus took a conscious step in ensuring the representation of women in the study. This was critical in understanding how the outcomes of climate change and the use of conservation farming affects women and men differently. Isgren (2012) also argues that experiences from the use of participation in research have revealed that the process of initiating participation is slow particularly in the early stages of the research where new relationships and trust have to be built between the researcher and the farmers. The researcher bridged this gap by creating rapport with the farmers before the process of data collection began.

This was aimed at ensuring that the smallholder farmers are comfortable and at ease in sharing information with the researcher. This aspect was key in ensuring that the researcher gathered data that was reliable in the planned time frame.

### **2.16.2 Sustainable livelihoods approach**

The sustainable livelihoods framework is based on the premise that there are various elements that play a role in limiting as well as augmenting the capacity of disadvantaged people in the community to meet their environmental, economic and social needs in a sustainable way. (Krantz, 2001). Morse and McNamara (2013) conceptualized a livelihood as consisting of capabilities, assets and activities essential for a means of surviving and the livelihood becomes sustainable if it can survive and recuperate from stress and shocks and in the process provide opportunities that are sustainable for future generations. Petersen and Pedersen (2010) posit that the sustainable livelihoods approach explains what development focused on poverty eradication should focus on to create sustainable livelihoods for the poor. Emphasis on the sustainable livelihoods approach is placed on understanding poverty as a dynamic notion that exceeds economic growth (Krantz, 2001). The theory is based on the principles that development interventions have to focus on the people understanding what is important to them, how they are unique and how their different cultures affect the way they comprehend and appreciate livelihoods (Morse and McNamara, 2013).

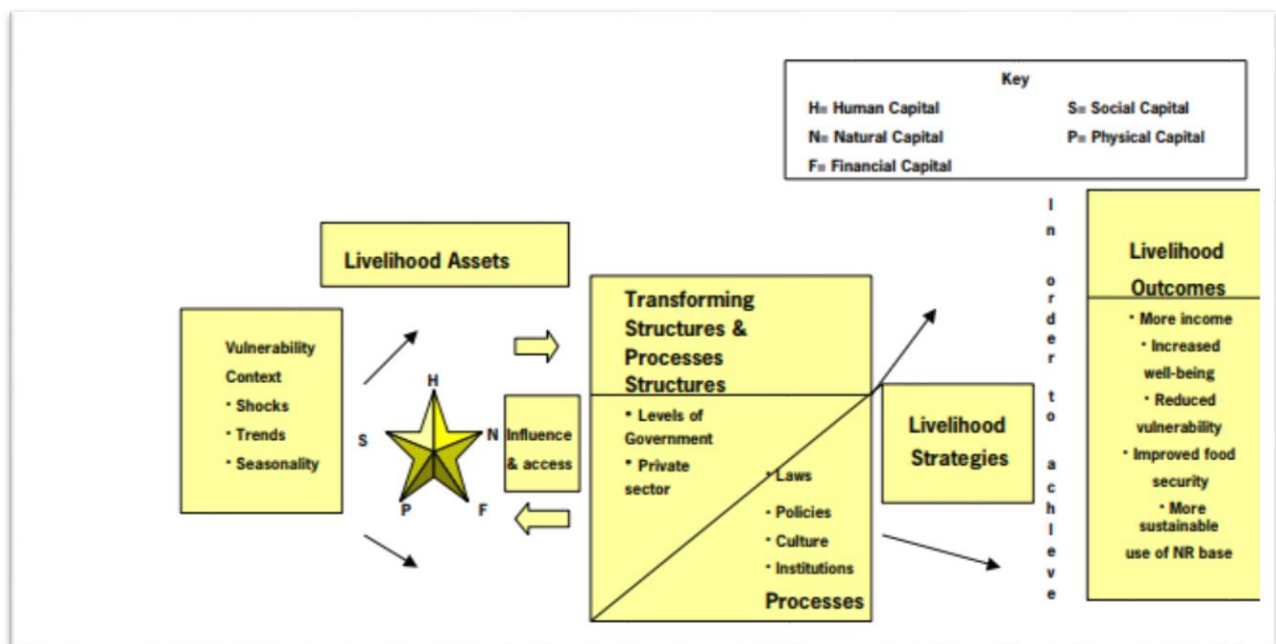
According to Krantz (2001), the sustainable livelihoods approach grew as proponents of the development agenda sought to maximize the benefits of their interventions in the quest to empower the disadvantaged in society. Alison and Hooremans (2015) explain that the sustainable livelihoods approach is important as it is a diagnostic tool that is used as a framework to analyse an intervention which is critical for concrete suggestions for the intervention. It is in this regard that this research used the sustainable livelihoods theory in analysing the effectiveness of conservation farming through assessing different factors highlighted in the framework that are key in ensuring that an intervention is effective. The sustainable livelihoods theory played a critical role in determining the factors that hinder farmers practicing conservation farming in Zimbabwe to improve agricultural productivity and hence promote food security. It should be noted that the sustainable

livelihoods approach in line with the participation theory values the concept of participation as critical in ensuring that development is accomplished from the poor people's point of view (Hooremans, 2015). Morse and McNamara (2013) argue that the inclusion of those who are affected by development interventions provides a platform for them to avail important information related to social norms that affect the access different people have to assets, how they view the assets or which livelihood strategies are easily accessible to them.

According to SIDA (2001) the sustainable livelihoods approach has four key capitals that influence the success of an intervention. These include the natural capital which denotes the natural resource stocks that include soil, water and air which are services critical for livelihoods (SIDA, 2001). It is critical to understand that the natural capital should be appreciated in a holistic way as it incorporates both concrete factors that include natural resources such as trees and land as well as intangible factors that include the atmosphere and biodiversity (Petersen and Pedersen, 2010). Krantz (2001) posits that the economic capital relates to the capital base that includes cash, economic assets, infrastructure and production technologies. These are the economic assets that individuals can utilize to attain the livelihoods that they desire. Human capital deals with the abilities, information capacity to work and decent health as well as physical ability which is critical for the success of a livelihood (Sibanda et al., 2002). Petersen and Pedersen (2010) explain that the human capital is the foundation of all the capitals as it plays a critical role in enabling the use of other capitals. Social capital relates to the social resources that have to do with social networks, social relations, affiliations, associations upon which people share experiences and learn from each other (Scoones, 2009). It is important to appreciate that the capitals may differ with respect to their ability to stand up to different shocks (Morse and McNamara, 2013). The study assessed how the various capitals affect smallholder farmers closely focusing on their influence on agricultural productivity.

Advocates of the sustainable livelihoods approach posit that the contexts in which households are run involves numerous threats or shocks that render them vulnerable to negative livelihood outcomes (Chinsinga, 2003). Thus the implication of the theory is that farmers need diverse resources or capitals to increase agricultural productivity (Sibanda et al., 2002). As such, the theory

was instrumental in determining the factors that hinder farmers practicing conservation farming in Zimbabwe to improve their agricultural productivity. This theoretical framework was of importance as it further provided the prescription needed to enhance the effectiveness of conservation farming in improving agricultural productivity in a district adversely affected by the hostile vagaries of climate change. Krantz (2011) posits that the sustainable livelihoods approach provides a critical skill to those affected by development interventions in that when local people are included in the process of gathering data, analysing it and identifying learning opportunities with them, they acquire valuable information on how to handle the challenges they will face in the future and they are better involved in finding solutions to the challenges that they are faced with. This is a valuable skill in the community when pursuing sustainable development (Chinsinga, 2003).



**Figure 2.4: Sustainable livelihood framework**

Source: Krantz (2001:19)

Toner (2002) is of the view that the poverty focus of the sustainable development approach is a reflection of the greater aim to global poverty eradication. It should be noted that this viewpoint has been subjected to criticism because of its suggestion that only the poor have livelihoods that they aim to sustain over their lifetime whilst the rich have life styles that evolve and alter in the course of their lives (Achoma, 2009). This criticism is critical as it reveals that there are various factors that influence the livelihood outcomes of the community (Giachetti, 2005). Morse, McNamara and Achoma (2009) argue that the sustainable livelihoods approach fails to appreciate that individual needs are complex in the process ignoring the importance of taking into account broader policy and institutional perspectives. It is in this regard that the study assessed factors affecting agricultural productivity among smallholder farmers based on the unique experiences of the farmers as they are the ones affected by the intervention.

### **2.16.3 New institutional economics**

The new institutional economics approach plays an outstanding role in influencing land reform viability debates in Southern Africa facilitating for a pro poor kind of land reform emphasizing on farm efficiency and economic growth (Scoones, 2009). Ankarloo (2014) explains that institutions are both informal constraints that include culture, custom, incentives and taboos and formal constraints that include law and property rights. Therefore it is the interaction between institutions and organizations that shapes the institutional evolution of the economy (Ankarloo, 2014). The research thus established how institutions are affecting smallholder productivity and the complete adoption of conservation farming in a country deeply affected by climate change. Cousins and Scoones (2009) claim that the major focus of the new institutional economists is to have policies that allow land to be easily accessible in the markets and also provide farmers with secure land tenure rights. According to Alston, Mueller and Nonnemacher (2014) the norms and laws of society play a role in the distribution of economic property rights. As such an economic or *de facto* property right allows a farmer to exercise a choice over a good or service without penalty and these choices include using, selling and achieving an income from the asset (Allen, 1998). Alston et al., (2014) are of the view that legal or *de jure* refer to the property rights stipulated by law and enforced by the government. Alston et al. (2014) claim that farmers seek to solidify their claim to

land by gaining legal title to it. The underlying premise of new institutional economics is that markets need institutional support in the form of an effective state (Ankarloo, 2014). The outcomes of structural adjustment reforms influenced by neoliberalism confirmed that Africa cannot leave the welfare of its people in the mercy of an unregulated market, hence showing that the state has an important role to play in influencing development (Gumede, 2017). The research thus sought to understand if the state is playing a role in assisting smallholder farmers against the factors affecting the adoption of conservation farming. The thought by the new institutional economics approach - sometimes referred to as neo populist - is that in as much as farmers are viewed as rational beings there is need for institutions in the market that will support farmers (Ankarloo, 2014). The argument being that there is often an inverse relationship that exists between the area of land that is harvested and the area of land planted. This inverse relationship is as a result of absence of real markets in the form of information and resources. (Deininger, 2003). Ankarloo (2014) posits that a well-functioning market economy is based on an effective institutional framework, hence the recognition that economic development without good institutions and an effective state is impossible. An investigation by FAO (2000) revealed that poorly functioning markets that result in failure by farmers to access the market in terms of labour and resources was discovered to be one of the major contributors of poverty. Cousins and Scoones (2009) thus agree on the need for macro-economic changes to address the challenges that farmers face. It is in this regard that the research identified the factors that affect the full adoption of conservation farming. This was key in determining the reasons for the inverse relationship between area planted and area harvested. The new institutional economics theory guided the researcher in establishing whether the property rights accorded to the farmers in Zimbabwe play a role in affecting agricultural productivity. The new institutional economics theory was of importance as it guided the researcher in assessing the role played by the market in promoting agricultural productivity. The theory was key in establishing the factors from a market level perspective that account for low agricultural productivity.

Alston et al. (2014) posit that transaction costs are a key aspect in the new institutional economics theory. These are the costs that arise when two individuals engage in an economic transaction (Haller, 2002). The concept of transaction costs was founded on the work pioneered by Coase in



his article *The Nature of the Firm* in 1937 (Kherallah and Kirsten, 2001). Scoones (2009) maintains that whilst smallholder farmers are viewed as rational decision makers, the presence of real markets is often not seen because of the presence of high transaction costs that include the cost of monitoring farm labour or enforcing contracts. Haller (2002) explains that it is crucial for institutions to work properly as this has a net effect of reducing transaction costs. Bhardan (2013) argues that institutions that evolve to lower transaction costs are instrumental to the performance of economies. Thus smallholder farmers can only be efficient even if there are external forces that include the negative effects of climate change as long as the costs of transacting are minimum and property rights are evidently defined (Scoones, 2009). Mkandawire and Soludo (1998) maintain the need for a holistic policy plan for countries in Africa arguing for a proactive role of the state in the context of a fundamental market economy. Mkandawire and Soludo (1998) stress that Africa has the capacity to contest in a progressively globalized world. Attaining such a challenging task cannot be possible without the active role of the state (Scoones, 2009). Mkandawire and Soludo (1998) add that capacitating Africa is not simply a matter of eliminating the role of the state and depending on liberalising the economy through trusting market forces but entails innovation and taking risks in making decisions that are likely to produce immense advantages for African countries in the long term. The recommendation is for the state to come on board and take an active role in clearly defining property rights and reduce transaction costs (Cousins and Scoones, 2009). This brought about the need for the research to provide recommendations on how transaction costs that are affecting smallholder farmers can be lowered at the same time improving agricultural productivity.

#### **2.16.4 Diffusion of innovations theory**

Everret Rodgers in 1995 developed the diffusion of innovations theory where he outlines the different steps of innovation that affect decisions (Orr, 2003). The diffusion innovation theory is rooted through the need to explain how an idea or innovation gains momentum and spreads through a specific population (Sahin, 2016). The end product of this theory is that people will ultimately adopt a new idea and implement it (Rodgers, 2003). LaMorete (2016) goes on to conceptualize adoption as a scenario whereby individuals do something differently than what they have been

previously doing. The key principle to this theory is that an individual has to perceive an idea or certain way of doing things as innovative for diffusion to take place (Sahin, 2016). Orr (2003) posits that diffusion denotes a procedure where invention of a certain idea is communicated over several avenues overtime among groups of the same social system. Studies have shown that individuals who adopt an innovation early have different traits to those who adopt an innovation later (LaMorete, 2016). Thus the implication for the research was to take an active role in understanding the characteristics of the target population that will help to focus on whether adoption will take place (LaMorete, 2016). The assumption behind the theory is that the decision making process is not imposed or shared and hence each unit of the social system goes through a five step decision process (Orr, 2003). Rodgers five step stage model outlined by Orr (2003) entails

1. Knowledge - This is a situation whereby a person becomes conscious of an innovation and has knowledge of how the new invention works (Orr, 2003). Sahin (2006) notes that at the knowledge stage, an individual seeks to understand what the innovation is, and how and why it works. Rodgers (2003) acknowledges three different forms of knowledge that include, awareness knowledge, how to knowledge and principles knowledge. Awareness knowledge is a scenario whereby an individual is mindful of the presence of an innovation and this awareness stimulates the individual to understand more about the innovation in the process lay fertile ground for its adoption (Orr, 2003). The second type of knowledge which is the how to knowledge seeks to gather data on how to use an innovation correctly (Sahin, 2006). The implication by Rodgers (2003) is that in order to increase the adoption chance of an innovation it is critical that individuals should have sufficient knowledge on how to use the innovation prior to making them use the innovation without understanding it. The principles knowledge which is the third type of knowledge seeks to describe how and why an innovation works (Orr, 2003). The premise behind this type of knowledge is for individuals to understand the value addition of the product when they use it (Rodgers, 2003). Hence it was critical for the research to establish whether smallholder farmers have awareness on how conservation farming works, whether they have been fully trained on how to practice conservation farming and whether smallholder farmers understand the full benefits of using conservation farming as opposed to the conventional method of farming.

Persuasion- this is a situation where an individual develops an attitude which may either be favourable or not towards the new innovation (Sherry, 2002). Sahin (2006) posits that whilst the knowledge stage is cognitive as it has to do with knowing about the product, the persuasion stage is more affective as it has to do with how an individual feels about an innovation. Rodgers (2003) posits that persuasion is affected by the degree of uncertainty of how the innovation works and the social reinforcement from other peers. Sherry (2002) argues that whilst knowledge exists from teachers and different experts, adoption will be influenced by the way in which subjective opinions of the innovation from friends and colleagues are most convincing. The study thus assessed how the opinions of other peer smallholder farmers have affected the way in which smallholder farmers have adopted the use of conservation farming against the background of the challenges that they are experiencing.

2. Decision - This is a situation where a person goes through various thought processes that determine whether they choose to accept the idea or not (Sahin, 2006). At this stage Rodgers explains two types of rejection that include active rejection and passive rejection (Sahin, 2006). Rodgers (2003) explains that active rejection denotes as situation whereby an individual decides to experiment and try out a new innovation but later decides not to adopt the innovation. Passive rejection on the other hand is a situation whereby the individual does not envision adopting the innovation at all (Sherry, 2002). Rodgers (2003) stresses the view that group influence plays a critical role in aiding an individual in the decision stage, and this leads to a situation where there is collective innovation decision adoption as opposed to personal innovation decision adoption. This stage played a role in equipping the researcher with knowledge on whether the challenges associated with the use of conservation farming by smallholder farmers is as a result of rejection by smallholder farmers.
3. Implementation - Rodgers (2003) explains that at the implementation stage the person puts the new idea into use. Uncertainty on the adoption and outcomes of the new innovation is still a critical hindrance at this stage (Sahin, 2006). This brings about the need to reduce the degree of uncertainty by providing valuable information to the farmers that is

instrumental in reducing uncertainty. Rodgers (2003) articulates that at this stage the process of reinvention takes place. This is a process where a new idea is discovered and created and this makes the process of adopting the innovative idea more rapid. The implication to the study is that smallholder farmers should now be in a position to invent new ideas that will complement the innovative idea on the adoption of conservation farming. Hence the research was instrumental in assessing whether farmers have taken an active role in coming up with new ideas to making conservation farming more effective and efficient against the background of the challenges that they are facing.

4. Confirmation - At this phase the person is compelled to evaluate the outcomes of the new idea (Sherry, 2002). At this stage the idea of adopting the new innovation can easily be replaced if the individual is faced with conflicting views on the adoption of the innovation (Rodgers, 2003). According to Sahin (2006) it should be noted that this is a crucial stage where the individual is looking for information to support their decision of adopting the new idea. Rodgers (2003) posits that at this phase attitudes become increasingly important. Therefore reasons for rejecting the innovation may arise due to the individual adopting a better innovation and replacing the recommended one which is termed replacement discontinuance (Orr, 2003). The individual can also reject the use of the innovative idea simply because he or she is not satisfied with its performance or the innovation is divorced from the context specific needs of the individual hence failing to provide a context specific relative advantage to the individual which is a critical element towards affecting the adoption of an innovation. This state has been termed disenchantment discontinuance (Rodgers, 2003).

Orr (2000) argues that the most interesting part of the theory is that other members in the group have an influence on whether the innovation decision will be accepted. This is an indication of the power of peer pressure in the adoption of an innovation (Rodgers, 2003). The use of the diffusion innovation theory guided the researcher in understanding the nature of conservation farming practiced in Zimbabwe. This included establishing whether farmers practicing conservation farming in Umguza District had knowledge on how the farming approach works. The theory was also useful in understanding the views and attitudes of farmers on the use of conservation farming.

This was critical as it played a role in determining the outcomes of the use of conservation farming. The theory was vital in helping the researcher understand whether farmers made a voluntary decision to accept the use of conservation farming or it was a decision based on influence of other members in the system. Ultimately the theory was central in providing solutions to the efforts needed to encourage the spread and success of conservation farming based on the mechanisms of diffusion that were uncovered in the study.

Rodgers (2003) argues that the adoption rate of an innovation is the speed at which an innovation will be adopted. The adoption rate is affected by relative advantage which the innovation is going to offer (Orr, 2003). That is to say will the innovation reduce the probability of some unwanted future that includes food insecurity? According to Sherry (2002) the second determinant of adoption rate is compatibility. Rodgers (2003) views compatibility as the magnitude to which a new technology is viewed as attuned to upheld values and individual experiences. The implication is that the introduction of a technology or innovation is valued as consistent with past experiences, existing values and needs of those to whom the adoption is targeted. Prah (2004) posits that development initiatives targeting Africans are most likely to be effective provided the innovative ideas introduced together with their channel of communication are aligned to the indigenous languages that provide an enabling environment for the information to spread to the targeted rural masses instantly.

A third determinant of adoption rate is complexity which deals with the extent to which the introduction of a new technology is appraised as demanding to use and understand (Rodgers 2003). The fourth determinant of the adoption rate is that of repeated trials; this focuses on the innovation being tried frequently as this is key in fostering fast adoption of the innovation (Orr, 2003). The final determinant of the rate of adoption according to Rodgers (2003) is observability, which is the extent to which the outcomes of the innovation are clearly evident to others. A key lesson of the diffusion innovation theory is that role modelling is the key motivational factor in the adoption of an innovation (Sherry, 2002). This brought about the need for the study to determine whether there are model smallholder farmers who have produced significant yields through the use of conservation farming despite the challenges faced in its adoption. Rodgers (2003) emphasizes that

getting individuals to adopt a new idea even though the benefits are visible is a challenge, thus it is important to ensure that the key factors that determine the adoption rate are considered to speed up the innovation diffusion process (Sahin, 2003).

## **2.17 Sustainable livelihoods as the guiding theory for the study**

Principally, the study was guided by the sustainable livelihoods approach. This is because of the role the sustainable livelihoods approach plays as a diagnostic tool to analyse an intervention which is important for tangible recommendations for the smallholder farmers (Krantz 2001). The use of the sustainable livelihoods theory was important in ensuring that the study gathers information from the smallholder farmers from a people centred point of view. Putting the smallholder farmers at the centre of the research was vital in ensuring that the issues affecting smallholder farmers in the implementation of conservation farming are gathered from the people who are directly affected by the intervention. Through the sustainable livelihoods approach the effects of conservation farming among the post 2000 land reform smallholder farmers were assessed. The data collection tools used focused on generating data related to the five capitals that form the core basis of the sustainable livelihoods approach as mainly noted by the Likert Scale questions that were used in the questionnaire (Morse and McNamara, 2013). An understanding of the five capitals was vital in assessing the assets and vulnerability context of the smallholder farmers as proposed by the sustainable livelihoods theory. It was critical for the study to identify if smallholder farmers have the financial capital in the form of access to credit that is needed for them to implement conservation farming systems. This was done through assessing whether the smallholder farmers have the financial power to access inputs needed to implement an effective conservation farming system. Through the use of this theory it was critical to establish the extent to which smallholder farmers have human capital to implement conservation farming systems. An understanding of human capital entailed assessing the extent to which smallholder farmers have skills and knowledge on the implementation of conservation farming systems. The sustainable livelihoods approach also assisted the researcher in establishing the extent to which the smallholder

farmers have the natural capital to implement conservation farming systems. An assessment of the natural capital focused on gathering data related to access to land, water and the type of soil that smallholder farmers have. Through the use of the sustainable livelihoods theory the researcher was able to gather data related to the social capital for smallholder farmers. An understanding of social capital was vital in assessing the extent to which smallholder farmers are making use of social networks and family ties as they implement conservation farming systems. The physical capital of the smallholder farmers was also assessed and this was key in establishing whether smallholder farmers have access to the necessary infrastructure and resources needed for them to effectively implement conservation farming systems. Su et al. (2018) agree that the sustainable livelihoods framework has demonstrated to be an effective tool in analysing the long term outcomes or impact of development interventions that are aimed at bringing about change in the community through their emphasis on indigenous views and the experiences of the local community. The need to understand the personal experiences of smallholder farmers called for the necessity to employ a design thinking approach in the research design. This was vital in making use of the principles of design thinking that emphasize the need to empathise with smallholder farmers in a bid to understand their experiences as they implement conservation farming. The approach was instrumental in providing the meat and juice needed to examine the association between the adoption of conservation farming and the increase in agricultural productivity which is important in analysing the effects of conservation farming. The need to analyse the association between the adoption of conservation farming and increase in agricultural productivity triggered the use of the natural experiment as a research design that can be used to compare data from smallholder farmers making use of conservation farming and those making use of the conventional method of farming. This analysis was drawn from the experiences of the smallholder farmers to establish the kind of relationship that exists between the adoption of conservation farming and the increase in agricultural productivity.

The sustainable livelihoods approach emphasizes the need for a livelihood in this case conservation farming, to have the capacity to thrive, cope and survive from pressure or blows in the process either retain or augment abilities and assets and thus provide livelihood opportunities for subsequent generations (Su, 2018). This tenet of the sustainable livelihoods approach formed the

basis in identifying challenges and opportunities on the adoption of conservation farming in Zimbabwe. Understanding the challenges and opportunities was central in analysing the effects of conservation farming in Zimbabwe. This was critical in determining the value of adopting conservation farming as a livelihood strategy aimed at increasing the agricultural productivity.

Silva (2015) posits that for livelihoods to be sustainable they realistically need the utilization, conservation and improvement of assets and capabilities that include the financial capital, human capital, natural capital, social capital, physical capital and the political capital. Su (2018) explains that the sustainable livelihoods approach can be used to analyse various livelihoods of a community and in the process also find possible tactics to make livelihoods more productive and sustainable. This principle of the sustainable livelihoods approach was vital in establishing the determinants of conservation farming adoption and sustainability. An understanding of the determinants of conservation farming was instrumental in instituting solutions that will strengthen the effectiveness of conservation farming. This triggered the need to engage the community in the development of a prototype for implementing conservation farming systems that are sustainable and meet the localised needs of smallholder farmers.

Su (2018) acknowledges that the sustainable livelihoods approach is a people centred school of thought that emphasizes the need to involve the community in development albeit with challenges. The study adopted a people centred methodology in the form of the case study approach that ensured that the local smallholder farmers are involved in explaining the nature of conservation farming that they are practicing and the extent of adoption. The focus on the community was also key in empowering smallholder farmers in coming up with solutions to the challenges that they face. It is in this regard that the researcher used focus group discussions, collected stories of most significant change either positive or negative from the participants in the focus group discussion, and allowed smallholder farmers to also respond to the questionnaire. This was critical in ensuring that the smallholder farmers who are affected by climate change are given an opportunity to highlight their experiences with respect to the use of conservation farming. The results were analysed and categorized according to the elements of the sustainable livelihoods framework.



## **2.18 Conclusion**

This chapter discussed the concept of conservation farming through highlighting the principles guiding the implementation of conservation farming that distinguish it from the conventional method of farming. The conceptual framework directed by the concept of adoption was discussed in relation to its important role in analysing the effects of conservation farming in Zimbabwe. The historical development of conservation farming across the globe was also traced, citing its accomplishments and challenges in the implementation process. The nexus between the adoption of artificial intelligence as per the demands of the fourth industrial revolution and the use of conservation farming as the new green revolution was discussed as this was vital in understanding the role that technology has played in advancing the effectiveness of conservation farming. The role of climate change as the force behind the implementation of conservation farming was articulated, this was critical in explaining the rationale for the adoption and utilization of conservation farming systems. Theories that guided the formulation of the study foundation were also discussed with the common theme recognizing the important role of community participation in advancing the sustainability of development interventions.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

The chapter outlines the research methodology, segmented in the form of the research design, which highlights the natural experiment and the case study approach that were used to analyse the effects of conservation farming. The target population for the study area is presented in this chapter together with the sample population and the sampling procedures used. The chapter also details the data collection process that was undertaken to collect data from the field through the active engagement of the key stakeholders. The process of enhancing the validity and reliability of the research is also explained. Quantitative and qualitative data collection methods were used to collect data, their importance and the nature of information generated is discussed in detail.

#### **3.2 Research paradigm**

The research adopted the post positivism research philosophy in guiding the study. This was based on the need to understand the effects of conservation farming from multi dimensions and perspectives as advanced by post positivism. Usually the most commonly used research paradigms in the social sciences include positivism, post positivism, constructivism and transformative paradigms (Perera, 2018). Panhwar and Shar (2017) explain that the post positivism paradigm emphasizes the need to declare study findings based on widely held opinions from the respondents. It is against this background that the research adopted the quantitative approach in a bid to gather popular views from the smallholder farmers related to respondents rating on the state of their agricultural productivity as well as the respondents rating to the Likert Scale questions that sought to establish respondents standing to the key capitals underpinning the sustainable livelihoods framework which was the main theory guiding the research. Through the use of the qualitative

approach the researcher also looked out for recurring themes and sub themes based on the responses of the participants. This was key in understanding the commonly held views which reflect the issues important to the programme clients. As such a deliberate focus was made on the modal views of the respondents in understanding the possible effects of conservation farming in Zimbabwe.

Creswell (2009) posits that post positivism encourages the triangulation of qualitative and quantitative data collection methods when carrying out a study. This is based on the intentional philosophy to use multi methods and multi dimensions in comprehending the research phenomenon. Hence the study used both quantitative and qualitative research methodologies in the collection and analysis of data. Close ended questions in the questionnaire for the smallholder farmers formed the quantitative aspect of data collection and the use of the statistical packages for social sciences in conducting student's t- tests and the analysis of data contributed to the quantitative part of data analysis. The use of qualitative methods in understating the experiences of the smallholder farmers was done through the use of focus group discussions, the use of the interview method and the collection of stories of most significant change. This was aimed at understanding the experiences of the smallholder farmers from a subjective point of view which was vital in complementing the findings of the study established through the use of quantitative methods.

Panhwar and Shar (2017) explain that post positivism as a research paradigm recognizes the value of all study findings whether quantitative or qualitative appreciating the importance of all the findings in adding valuable knowledge to the research field. Through empathizing with the different smallholder farmers during the process of data collection, the researcher went on to develop a prototype based on the information received from the smallholder farmers either qualitative or quantitative. This was in recognition that all the data gathered from the study was important in framing a conservation farming model that provides a solution based approach to the challenges experienced by the smallholder farmers.

Post positivism acknowledges that there is no perfect research approach that can bring about results that are entirely one hundred percent perfect (Creswell and Clark, 2011). This is because of the understanding that all methods have their strengths and limitations, though it is critical to harness on the strengths of the chosen research approach and work on minimizing the associated limitations.

The research made use of the natural experiment as part of the research design aimed at comparing the agricultural productivity of smallholder farmers making use of conservation farming and those smallholder farmers making use of the conventional method of farming. The use of the natural experiment for the study provided the researcher with the opportunity conduct a true experiment as would have been the case with the use of methods such as randomized field experiments and quasi experiments that are costly in their nature but provide the opportunity to objectively measure cause and effect relationships. Though the use of the natural experiment provided the researcher with the opportunity to conduct a true experiment in assessing the outcomes of using conservation farming, the use of the method had its limitations associated with confounding factors related to the continuous support in terms of inputs that smallholder farmers using conservation farming receive as compared to those using the conventional method of farming. However what was important for the study was to establish whether agricultural outcomes for those smallholder farmers making use of conservation farming were significant in comparison to those smallholder farmers making use of the conventional method of farming.

Panhwar and Shar (2017) claim that post positivism appreciates the personal experiences of the respondents in informing study findings. It is in this regard that a deliberate effort was made in gathering data on the personal experiences of the farmers related to their gender, age, level of qualification as well as the number of years they have experienced as smallholder farmers. Having an understanding of the personal experience of the smallholder farmers was instrumental in comprehending the challenges faced by smallholder farmers in the implementation of conservation farming systems as well as the factors hindering the adoption and maximum utilization of conservation farming.

Post positivism recommends the need to assess the study findings in the natural environment of the respondents (Cresswell, 2009). This is based on the premise that understanding and having an experience of the respondent's natural environment is important in understanding the research phenomenon as well as coming up with solutions that address the problem in the context of the natural environment. (Fox, 2008). Through utilizing the case study as a research design, the researcher was able to visit Umguza District, interact and observe smallholder farmers in their natural environment. This provided an enabling environment for the researcher to partner with the smallholder farmers in ideating possible solutions to address the challenges faced by smallholder farmers in relation to their natural environment.

### **3.3 Research design**

The researcher used a case study approach that was important for in-depth explanations exploring the outcomes of adopting the use of conservation farming in the process embracing both qualitative and quantitative research approaches (Cresswell and Clark, 2014). Openheimer (1990) conceptualized the research design as the basic plan or strategy of the research which makes it possible and valid to draw conclusions from. The qualitative research approach was used based on its strength in providing holistic and in-depth explanations that were necessary in understanding the opinions of farmers practicing conservation farming in Umguza District. Atkinson and Delamont (2010) point out that qualitative researchers seek to uncover deep rooted mechanisms of individuals and the motives that drive such conduct. This enables more multifaceted variables of an individual's experience to be assessed. A quantitative research approach was also adopted which enabled the researcher to objectively describe the opinions of the respondents. Harwell (2011) argues that adopting a quantitative approach endeavours to maximize objectivity, replicability and generalizability of the findings in a way that is independent from the perceptions and biases of the researcher as such ensuring objectivity of the findings by the researcher.

### 3.4 Design thinking approach

The design thinking concepts were used to guide the study. According to Dam and Siang (2018) design thinking is an interactive concept that aims at appreciating or understanding the respondent's challenges and problems with the objective of coming up with strategies and solutions that may not be apparent with our primary level of understanding hence a solution based concept to solving the challenges faced by smallholder farmers.



**Figure 3. 1: Principles underpinning design thinking.**

Source: Dam and Siang (2018:3)

#### 3.4.1 Empathy

Collection of data directly from the smallholder farmers through administering the questionnaire and through engaging in focus group discussions was a critical step in empathising with the smallholder farmers in understanding their experiences through the use of conservation farming. The principle of empathy emerged as a reaction to the top down approach of the development agenda that saw individuals external to the community prescribing solutions to address the

challenges faced by the local people without the drive to understand the problems from the perspective of those who are directly affected (Dam and Siang, 2018). It is in this context that the concept of empathy recognizes the important role that various stakeholders play in addressing challenges faced by community members (Mootte, 2013). According to Joosten (2017), understanding empathy requires an assessment of the extent to which various stakeholders in the community are actively engaged in establishing the problems that they face as a society. According to Dam and Siang (2018), the process of empathizing with the community requires that the researcher understands the experiences of the local people. This concept demands the ability to connect with the way in which the respondents feel and appraise an intervention that has been directed to them (Mootte, 2013). The implication for the research was to identify the key personae critical in the implementation of conservation farming systems. A persona is conceptualized as a target group in a population that is in a position to provide valuable information in guiding the researcher to effectively understand the research phenomenon and provide a starting point in brainstorming solutions that can be adopted to deal with the research problem (Joosten, 2017). The key personas identified included the smallholder farmers using conservation farming, those using the conventional method of farming and the agricultural extension officers. Identification of these key personae called for the need to collect data from the three groups. Collection of data from the smallholder farmers making use of conservation farming was vital in establishing the nature of conservation farming practiced in Zimbabwe, the opportunities and challenges experienced in making use of conservation farming systems together with examining the association between the adoption of conservation farming and the increase in agricultural productivity. Empathizing with smallholder farmers who are making use of the conventional method of farming was critical in establishing the factors hindering the adoption of conservation farming paying particular attention to the issues raised by smallholder farmers in explaining the challenges that they are faced with in their quest of making use of conservation farming. Through empathizing with the Agricultural Extension Officers the research was able to identify variables affecting the objectives guiding the study from an expertise point of view.

### **3.4.2 Defining**

The principle of defining spells out the need to bring clarity on the focus and the objective of the research (Mootte, 2013). The critical aspect in this concept is to define the challenge through an actionable problem statement to the respondents (Dam and Siang, 2018). According to Wyatt and Brown (2010) the ability to define the challenge to the respondents is aimed at engaging the respondents to participate in tackling the problems they are facing with the hope of identifying sustainable solutions to the challenges that they face. Through the process of data collection the researcher began by explaining the purpose and the objectives of the research. The researcher then went on to define the challenge to the respondents as ‘how might we improve conservation farming to increase agricultural productivity’. Understanding this challenge entailed deliberately explaining the purpose of the research and articulating the important role that respondents have to play in analysing the nature of conservation farming together with the challenges and opportunities they are experiencing as they make use of conservation farming systems.

### **3.4.3 Ideation**

Dam and Siang (2018) explain that ideation as a principle emphasizes the need to transition from identifying problems to a state of creating solutions to address the challenge. The concept emphasizes the need to have a wide range of solutions before ultimately selecting the best solution to the varying options (Joosten, 2017). Mootte (2013) notes that consolidating the different views of the respondents with their active participation is instrumental in coming up with a solution based approach to dealing with the challenges experienced by the community. By harnessing different perspectives in coming up with possible solutions to address the challenges experienced, the concept of ideation seeks to explore areas that have not been covered before in the process propelling a culture of innovation among those affected by the challenge (Dam and Siang, 2018). Through the use of the focus group discussions different perspectives were gathered on possible recommendations that can be implemented to improve the effectiveness of conservation farming. The recommendations that were highlighted were characterized by different views and



perspectives that were all vital in contributing to the formation of the prototype for implementing conservation farming.

#### **3.4.4 Prototyping**

According to Dam and Siang (2018) the principle of prototyping presents ideated solutions as a tangible prototype model. The presented model provides the opportunity for further research to test and reconstruct the model in a cost effective manner (Joosten, 2017). Wyatt and Brown (2010) argue that the process of prototyping entails actively engaging the respondents to participate in the design of a model that they believe will be critical in solving their challenges. The concept recognizes the need to tie various thoughts and perspectives in coming up with a prototype model (Dam and Siang, 2018). Wyatt and Brown (2010) posit that the concept of prototyping provides a cost effective approach of bringing abstract ideas into life and in the process providing opportunities for continuous learning in pursuit of coming up with a sustainable solution based model. Through the use of the prototyping concept the researcher got the opportunity to frame a prototype for implementing conservation farming systems. The prototype for implementing conservation farming was a key starting point in enabling smallholder farmers to participate in the development of a conservation farming model that is localized to their unique context. The development of a localized model of conservation farming is an important variable that is also grounded on the theory of participation that is vital for the ownership and sustainability of conservation farming systems that seek to increase agricultural productivity.

#### **3.4.5 Testing**

The principle of testing is based on the premise that once a prototype model has been established there is a need to test to see if the model is effective in yielding the desired results (Dam and Siang, 2018). This concept places value in learning and understanding what works with the aim of tailor making the model based on the lessons learnt (Wyatt and Brown, 2010). The development of a prototype model of conservation farming provided a research gap with the need of a study that will assess the effectiveness of the prototype in strengthening conservation farming and ultimately improving agricultural productivity. The room to allow for testing of the model is critical in

triggering research studies that will test the model, scale if it is effective or remodel to make the model more effective.

### **3.5 The natural experiment**

The study made use of the natural experiment in analysing the effectiveness of conservation farming in increasing agricultural productivity. Craig and Cooper (2010) conceptualized a natural experiment as one in which the researcher does not have to manipulate the environment as participants are naturally studied without the alteration of the environment. According to Dunning, (2016) the natural experiment is used as a research design when controlled experimentation that is associated with the use of randomized field experiments and quasi experiments is extremely difficult to implement and is also unethical. The use of the natural experiment provides a practical and cost effective method of analysing the impact of an intervention as supporting data is already available in national data sources (Rossi, 2013). The popular understanding in the conceptualisation of natural experiments is that the researcher has not intentionally manipulated the exposure to an intervention as this has been naturally done by smallholder farmers who chose to make use of conservation farming hence being exposed to the intervention (Craig and Cooper, 2010). This would have been made possible without the deliberate effort by the researcher to select participants to the treatment group and then administering the intervention as would have been the case with the use of randomized field experiments (Dunning, 2016).

What differentiates a natural experiment from a randomized field experiment is that if the researcher had used a randomized field experiment the starting point would have been to first identify a group of smallholder farmers who share similar characteristics. The next stage would involve randomly assigning respondents to either control or treatment groups. The third stage will involve administering an intervention to the treatment group which entails deliberately allowing those in the treatment group to use conservation farming and deliberately making those in the control group to use the conventional method of farming. After harvesting time, impact will be assessed through measuring the agricultural output of those using conservation farming and those

using the conventional method of farming. The difference in the output harvest will be used to measure the impact. It should be noted that making use of randomized field experiments will be costly in terms of the time taken to administer the treatment as well as the resources needed to enable smallholder farmers to make use of a certain farming approach so as to measure impact. The use of randomization will also be unethical because farmers who will be told to make use of the conventional method of farming will be denied an opportunity to adopt a farming approach that will give them an opportunity to increase agricultural productivity and achieve food security. However with the use of the natural experiment the researcher establishes a control and treatment group through selecting farmers who are already making use of conservation farming who naturally form the treatment group and those who are already making use of the conventional method of farming who become the control group. This saves on time as participants are studied in their natural environment and there is no need to administer an intervention and wait to see if the intervention works since there is a group that is already making use of the intervention.. The researcher does not decide for the farmers on the type of farming approach to adopt for experiment purposes and this addresses the ethical challenge. According to Rossi (2014) when using natural experiments it is important to make sure that the participants that are identified as already making use of the intervention and those identified as not making use of the intervention share similar environmental characteristics as this is vital in measuring the impact of the intervention

The advantage of using natural experiments is that the design enables situations to be placed in a real world view, enabling assessments to be done in the natural world without any manipulation of the environment hence making the responses gathered much more relevant (Imas and Rist, 2009). The use of the natural experiment provided an enabling environment for the researcher to engage the study participants in their natural environment which was instrumental in enhancing the reliability of the data collected. This was possible because farmers were studied in their regular environment making the responses much more relevant, limiting the probability of participants changing their true behaviours as would have been the case with true randomized experiments.

Natural experiments are observational assessments which can be used to investigate the effects and results of policy interventions and are quite relevant when there has been a clearly defined

exposure involving a well-defined population as well as the absence of the exposure in a similar sub population such that the changes in outcomes may be plausibly attributed to the exposure (Freedman, 2010). Through the use of this design, the researcher was able to assess the outcomes and impacts related to agricultural productivity which are associated with the adoption of conservation farming through selecting defined smallholder farmers who are already making use of conservation farming and placing them as the treatment group because of the exposure they have of using conservation farming and also identifying a sub population of smallholder farmers who are not exposed to the intervention thus constituting those making use of the conventional method of farming. Dunning (2016) explains that natural experiments unintentionally provide the platform for a true randomized experiment to be conducted closely following the principle of cause and effect. As such the use of the natural experiment in the study ignited a solid foundation for internal validity in the research as the enquiry closely assessed the theorized relationship of adopting conservation farming and increase in agricultural productivity. Through the use of the natural experiment, the research assumed that other confounding variables that include the inputs used such as type of fertilizer and type of maize seed were constant across farmers using conservation farming and those using the conventional method of farming.

It should however be noted that unlike experiments such as randomized field experiments and quasi experimental designs, natural experiments are only employed as study designs when controlled experimentation is completely difficult to implement or is unethical (Freedman, 2010). It is in this regard that this study took into account ethical considerations by ensuring that participants in the control group were not intentionally denied treatment in order to assess the effects of conservation farming as would have been the case with the use of a randomized field experiment. It is critical to appreciate that natural experiments have a common vision with true experiments as they are grounded on the principle of comparing outcomes across participants exposed to a treatment and those exposed to a control environment (Dunning, 2016). As such natural experiments basically study the effect of an independent variable, which is the intervention or treatment that has not been calculated or manipulated by the researcher on a dependent variable (Craig and Cooper, 2010).

**Table 3.1: The design notation of a natural experiment.**

<b>Natural Experiment</b>	<b>X (treatment)</b>	<b>Farmers practicing conservation farming (Treatment group)</b>	<b>O (Test)</b>
	(No treatment)	Farmers practicing Conventional farming(Control group)	O (Test)

Adapted from Dunning (2016:15)

Freedman (2010) posits that researchers have reached common ground in understanding the importance of using natural experiments in an attempt to analyse actual experiences of individuals through a random approach that assigns participants in different classifications of the independent variable. Hence natural experiments place participants in either treatment or control group through an approach that is not randomized but resembles randomized assignment (Rossi, 2013). It is against this background that the research compared agricultural productivity of maize output per hectare amongst smallholder farmers practicing conservation farming who formed the treatment group and those using the conventional farming method who formed the control group. The difference in agricultural productivity outcomes between the two groups was used to measure the impact. This research design was critical as it allowed the researcher to study the participants in a way that is reflective of a real experiment hence critical for ensuring internal validity. An important advantage of using the natural experiment is that it relies on data in a single population as members of the population serve as their controls (Craig et al., 2017).

Natural experiments take into account the influence of confounders in affecting the outcomes of an intervention (Craig and Cooper, 2010). Dunning (2016) posits that as with true randomized

experiments, the natural experiment in principle suggests that confounders that include those known and unknown are balanced in both the control and treatment groups hence eliminating the need to measure and control for confounding variables. The research aligned to this standard by ensuring that the farmers selected in both treatment and control group shared similar characteristics in terms of the climatic conditions they are experiencing, specialized services they are getting from Agricultural Extension Officers with the only difference being in the approach of farming chosen.

### **3.6 Case study**

The study made use of the case study approach to analyse the outcomes from farmers practicing conservation farming and those adopting the conventional way of farming. Neale, Thapa and Boyce (2006) define a case study as an approach that tells a story by capturing incidences that highlight a project's success. The case study approach provides outcome data that is necessary for evaluating the effectiveness of programmes (Rossi, 2013). A major advantage of the case study method lies in its ability to permit the researcher to present data that is collected from multiple sources that include interviews, questionnaires, focus group discussions and project reports among other methods (Neale et al., 2006). Interviews, questionnaires and focus group discussions were used to gather data. Zainal (2007) is of the view that through the use of the case study approach a researcher is able to go beyond the quantitative statistical results and understand the behavioural conditions through the participant's perspective. This was made possible by conducting focus group discussions and collecting stories of most significant change from the smallholder farmers which provided a platform for the views of the smallholder farmers to be clearly aired out. One gain of using case studies is that the examination of data is often done within the context of its use (Zainal, 2007). Essentially, this means that data was evaluated for the purposes of providing feedback and enhancing the effectiveness of conservation farming for the farmers in Zimbabwe.

Disparities between the inherent and holistic approaches for the use of case studies allow the need for shared analysis of quantitative and qualitative data (Yin, 2016). The study made use of quantitative and qualitative data collection and analysis methods. This is important because the

comprehensive qualitative details that emerge in case studies explain the complications of realities on the ground from the perspectives of the smallholder farmers which may not be sufficiently captured through experimental or survey research (Zaniel, 2007). The use of quantitative data was done to add rigor in data collection and analysis. Hence the questionnaire as a data collection tool consisted of both qualitative and quantitative questions whilst the focus group discussions and the interview guide represented the qualitative aspect of the research. The use of the statistical packages for social sciences formed the quantitative aspect of data analysis whilst the use of thematic analysis and nvivo formed the qualitative approach to analysing data in the study.

Yin (2016) posits that the quality of case studies can be judged according to four common logical tests that include, test for construct validity, test for internal validity, test for external validity and test for reliability. To meet the test for construct validity, it is critical for the researcher to use multiple sources of evidence in a manner encouraging convergent lines of inquiry and this tactic is critical during data collection (Cresswell, 2014). The use of the questionnaire, focus group discussion, interview guide as well as the collection of stories of most significant change provided a multi-source approach in collecting evidence data in the study. Yin (2016) adds that it is also important to test for internal validity when using case studies. Thus if the researcher hopes to establish whether **x** led to the conclusion **y**, the researcher has to investigate all threats to internal validity to avoid making an assumption that **x** led to **y** yet there was a third factor that led to **y**, hence the study looked out for potential confounders (Yin, 2016). Factors contributing to the increase in agricultural productivity for farmers practicing conservation farming divergent from the principles of conservation farming were analysed so as to determine the potential confounders affecting agricultural productivity.

The third test in case study designs has to do with establishing if study results can be generalized to a larger population (Yin, 2016). This is important because the use of the case study, design as with other experimental designs that include randomized field experiments, relies on analytical generalization where the researcher seeks to generalize results to a broader theory (Cresswell, 2014). According to Yin (2016) the key decision at this stage is to test theory through repeating

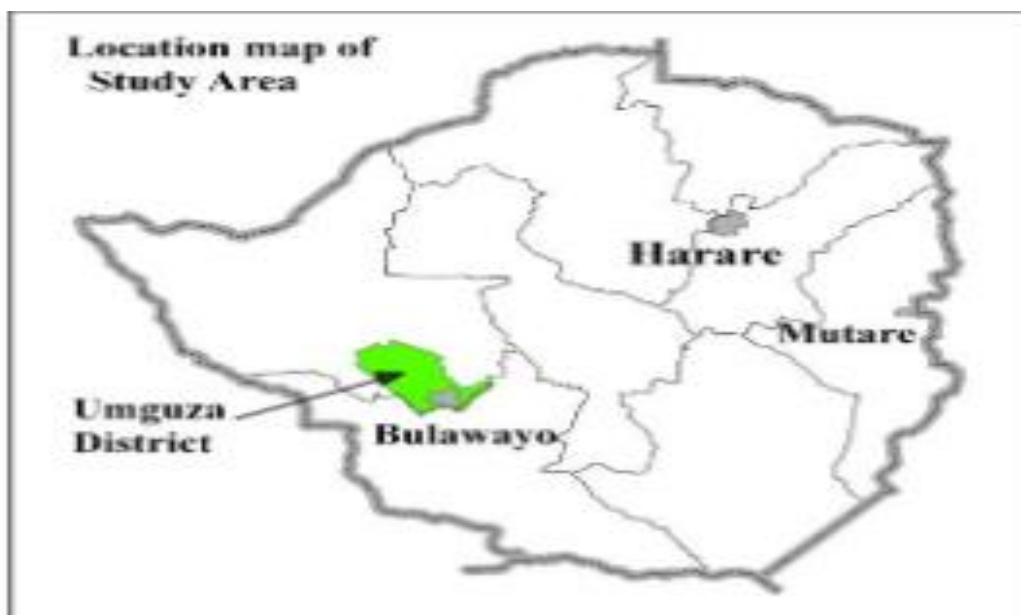
the process of data collection to test for internal consistency. This laid fertile ground for the results of the study to be accepted in much larger farming communities.

Yin (2016) argues that the final test in the case study design is that of ensuring that the study findings are reliable. The expectation is that if another researcher is to conduct the same study using the same procedures adopted in this study, the findings and conclusions reached should be the same (Cresswell, 2014). Hence, the researcher documented all the procedures followed in this study. Yin (2016) argues that without documentation you cannot even report your own work hence citing documentation as a way of dealing with reliability. It is in this regard that this study clearly documented its research design, methods of data collection, and the process of data collection as well as the methods of data analysis which was critical in increasing the possibility that when the study is repeated the findings will be similar.

### **3.7 Population**

Umguza District is located in Matabeleland North province Zimbabwe. PRD (2011) indicates that Umguza District has an estimated population of 61045 people comprising of 16067 households. William (2004) asserts that the term population describes the total quantity of the cases that are the subject of the research study. Umguza District falls within agricultural region four characterized by low rainfalls hence a district that is susceptible to food insecurity (Nkala, 2014). According to PRD (2011) livestock and crop farming are the major source of livelihoods that have been adopted by the community in Umguza District. Nkala (2014) posits that the changing weather patterns in Umguza District have threatened crop farming, a key livelihood source in the district. Therefore the study analysed the effectiveness of conservation farming in improving agricultural productivity in a district seriously affected by the vagaries of climate change.





**Figure 3.2: The geographical location of Umguza District.**

Source: Belle, Moyo and Ogundeji (2016:4)

### **3.7.1 Sampling frame**

The sampling frame for the research comprised of all communal farmers in Umguza District. Turner (2003) conceptualized a sampling frame as the set of source materials from which the study sample is selected. The list frame detailed the type of farming adopted in the different wards as well as the details of the various farmers. The sampling frame was obtained from the agricultural extension department. The sampling frame distinguished wards with smallholder farmers and those with commercial farmers which assisted the researcher to establish the wards to intentionally focus on in the study. The ability to numerically identify a farmer based on the type of farming approach adopted was useful in the assignment of smallholder farmers in either the treatment or control group in a logical and systematic manner.

### **3.7.2 Sample size**

Through the use of the sample size calculator focusing on a margin error of  $\pm 10$ , confidence level of 90% the sample size of the research comprised of 102 communal farmers. According to Cresswell (2014) a sample is the proportion of the population which the researcher investigates. Wallen (1996) conceptualized a sample as a group in a research study of which data is gathered of a populace selected since it is difficult, costly and unrealistic to collect data from all participants in the study covered by the research problem. According to ZIMSTAT (2012) the census report of 2012 highlights that wards 9 and 12 in Umguza District have a total of 2500 households with 1600 of these comprising of communal farmers. Fifty five percent of the communal farmers are said to be practicing conservation farming with 45% of the communal farmers using the conventional farming method (ZIMSTAT, 2012). The study was thus comprised of 102 communal farmers that included 51 who are using the conservation farming and 51 who are using the conventional method of farming. The study also included Agricultural Extension Officers who played a critical role in providing technical expertise to the farmers.

## **3.8 Sampling techniques**

### **3.8.1 Accidental sampling**

The accidental sampling method was used for the pilot study to test the effectiveness of the research tools that were used in a way that ensured time efficiency and cost containment. This is an activity that was done in ward 12 Umguza District. The ward was selected due to its dominance of smallholder farmers who are either practicing conservation farming or the conventional method of farming. According to Chaturvedi (2010) accidental sampling entails the convenient collection of members of the population that are readily available for the purpose of the research. However as a sampling method it is not likely to be representative but is a sampling technique which is quite useful for pilot testing (Turner, 2003).

### **3.8.2 Purposive sampling**

Purposive sampling was used to select the study area focusing on the wards where conservation farming is mainly practiced in Umguza District. A purposive sample is one that is grounded on the researcher's experience and judgment in selecting the participants they feel will be appropriate for the study (Chataturvedi, 2010). Thus the study purposively sampled wards 9 and 12 in Umguza District intentionally neglecting other wards that are largely comprised of commercial farmers. The study also purposively sampled 5 crop and livestock officers who have valuable knowledge on farmer experiences in Umguza District. Their willingness to participate in the study provided a podium for the crop and livestock officers to communicate their experiences and thoughts on the effects of conservation farming in the process providing rich information valuable to the study.

### **3.8.3 Simple random sampling**

The study made use of simple random sampling. This is a process that entailed identifying all the farmers in the farmer register provided by the agricultural extension officers. Random sampling is a procedure by which elements in the study area are selected by a random process which uses either a haphazard number generator or a random table generator so that each element in the area of study has the same chance of being nominated in the sample (Frerichs, 2008). Based on the agricultural extension report presented to the Umguza Rural District Council meeting for the period ending December 2017, 55% of the 1600 communal farmers are practicing conservation farming. The implication is that 880 farmers are using conservation farming whilst 720 are using the conventional method of farming. To come up with a sample of 51 participants for the treatment group, the researcher selected the 17<sup>th</sup> element in the sample frame provided for farmers using conservation farming and also selected the 14<sup>th</sup> element in the sample frame for farmers using the conventional method of farming to come up with 51 participants for the control group. This gave each communal farmer an opportunity to participate in the study. The selection of the 17<sup>th</sup> and 14<sup>th</sup> element for the two groups of farmers was influenced by the need to come up with a sample size of 102 with an equal representation from the two groups.

#### **3.8.4: Snowballing**

The researcher made use of snowballing to include other smallholder farmers who were in a position to provide important information for the research. Snowballing is a process by which existing participants in the study are used to recruit more members into the sample (Chataturvedi, 2010). The researcher inquired from the agricultural extension officer's information on participants whom they thought would provide more information about conservation farming and conventional agriculture in their ward. This ensured that the researcher gathered more accurate data that was important for the study from units that were not included in the original sample group.

### **3.9 Data gathering process**

The researcher began by seeking authorization from the provincial administrator for Matabeleland North province representing the ministry of local government and public works. The authorisation was granted in the form of a letter that was submitted to the district administrator for Umguza. The role of the district administrator was to introduce the researcher to the agricultural extension department, the councillors for ward 9 and 12 and the traditional chief covering the two wards. Seeking authorisation was critical in gaining support from the local leadership which made it easier to access the study respondents. A critical step was to first pilot test the questionnaire in English and IsiNdebele. This was important in monitoring the time spent in completing the questionnaire and in also understanding whether the respondents understood the questions in a similar manner. Based on the inputs from the smallholder farmers through a focus group discussion conducted, the researcher was able to amend some of the questions and also add other options in terms of answers to select from the questionnaire as recommended by the respondents.

Through an engagement with the agricultural extension department, the researcher made use of smallholder farmers registers to identify smallholder farmers making use of conservation farming and those making use of the conventional method of farming. The identification of the two groups

of farmers was critical in the assigning of smallholder farmers to either treatment or control group. Those smallholder farmers with records indicating that they are making use of conservation farming were categorised as the treatment group with those identified as using the conventional method of farming being assigned to the control group. The researcher then used simple random sampling to select smallholder farmers to be included in the sample size for those who are using conservation farming and also those who are using the conventional method of farming. The next stage then entailed administering the questionnaire to the smallholder farmers through the help of the research assistant as well as the Agricultural Extension Officers who were also conducting their monitoring visits. The researcher explained to the research assistant and the Agricultural Extension Officers the objective of the research and analysed the questionnaire to ensure that the questions were understood and all issues to do with ethics were addressed. The process of administering the questionnaire entailed visiting the smallholder farmers at their farms, making use of the addresses provided for in the agricultural extension registers. Upon contact with each smallholder farmer, the research team members would introduce themselves and explain the purpose of the research, clearly highlighting how the study findings would be key in helping smallholder farmers come up with their localised model of increasing agricultural productivity. This was a critical process in getting consent from the smallholder farmers to respond to the questionnaire. The researcher together with the research assistant would wait for the smallholder farmers to complete the questionnaire and collect it on the same day. This was critical in ensuring a high response rate.

Upon the completion of administering all the questionnaires, the researcher then went on to conduct focus group discussions with participants who were selected using the purposive sampling technique. The researcher ensured the deliberate inclusion of women in the focus group discussions as the agriculture sector is largely dominated by men. Five focus group sessions for ward 9 were conducted at Mahlothova Primary School whilst another five focus group for ward 12 were conducted at Nyamandlovu Secondary School. Through the assistance of the traditional leadership that included the chief for the area under study it was easy to mobilize the smallholder farmers for the focus groups. The smallholder farmers were also motivated to attend the focus group discussions based on the need for them to improve the state of food security in their villages

hence contributing to the study served as an incentive for them. As the researcher was conducting focus group discussions, stories of most significant change were also collected and this is a process that was intensely done through informal conversations with the smallholder farmers after the focus group discussions.

The researcher conducted in-depth interviews with agricultural extension officers. The interviews were conducted during the same period when focus group discussions were being carried out. Data gathered was subject to data cleaning, analysis and interpretation. A research report was then developed for data analysis. Upon completing the process of data analysis, the researcher went on to have a debriefing meeting with the study participants. The aim of the debriefing meeting was to explain to the participants the results from the study. This is in compliance with the principles of beneficence and non-maleficence which underscore the need for a research to be of value to the study participants in the process also not subjecting the respondents to any harm. Giving feedback on the research findings provided the platform for the researcher to design a prototype model of conservation farming in collaboration with the respondents. This was critical in ensuring that the research adds value to the smallholder farmers as they also get to be actively involved in designing their own localised solutions.

### **3.10 Data gathering instruments**

#### **3.10.1 Questionnaires**

One questionnaire was drawn up for 102 smallholder farmers in Umguza District. The questionnaire comprised of open ended, close ended and Likert Scale questions. The questions on the questionnaire were guided by the study objectives and the research questions to be addressed. Nachimias and Nachimias (1996) argue that questionnaires are an important method of collecting data particularly where, evidence based data is vital. The relevance of the use of questionnaires stems from their ability to provide an efficient means of generating and analysing data (Taylor, 1997). The questionnaire was subdivided into two sections that include the first section on the

socio demographic details of the respondents and the second section that focused on the experiences of the respondents as farmers. Information on socio demographic data was elicited from the respondents focusing on age, sex, level of qualification and number of years as a smallholder farmer. Socio demographic information was instrumental in assessing the role played by the background of the smallholder farmers in influencing their farming experiences. This is line with the diffusion innovation theory which emphasizes the need for individuals to understand how an innovation works based on their background and their understanding of the potential benefits of adopting that innovation. The section on the experiences of the farmers focused on establishing whether farmers understand the concept of conservation farming as well as the associated benefits of adopting conservation farming. The study questionnaire went on to investigate the challenges experienced by farmers with respect to adopting conservation farming. This provided the basis for the researcher to cross tabulate responses from farmers who have already adopted conservation farming and those using the conventional method of farming with respect to whether the perceived challenges are the same for both groups. Respondents were allowed to express their views on whether they received the necessary training to adopt conservation farming, whether they are aware of different technologies that can be used to scale up agricultural productivity and whether they have the different capitals needed for them to cope with the shocks of climate change. The sustainable livelihood theory emphasizes the need to assess the extent to which different capitals affect the way in which individuals are able to cope with shocks and in the case of this study climate change. Issues of land tenure rights, culture and transaction costs as clarified by the new institutional economics theory in relation with how they affect the effectiveness of conservation farming were also established through the questionnaire. The questionnaire also assessed agricultural productivity of maize in terms of area planted verses area harvested, this was critical in examining the association between the adoption of conservation farming and increase in agricultural productivity.

### **Benefits of Questionnaires**

- a. The use of the questionnaire made it possible for the data to be collected and to be analysed in a consistent manner hence allowing room for objectivity through the use of the tool.

Robson (1997) posits that unambiguous and precise questions provide an enabling environment for standardization which is essential in research.

- b. The use of the questionnaire made it possible to collect data from the smallholder farmers in alignment with the set time lines.

### **3.10.2 Focus group discussions**

Ten focus group sessions with an average of six participants were conducted with the two groups of farmers adopting the conservation farming method and those adopting the conventional farming method. Krueger (1994) is of the view that a focus group discussion is a dialogue that is planned carefully aimed at obtaining perceptions and views on a specific area of interest in a way that accommodates and protects all participants. Krueger (1994) adds that usually around six to ten people participate in each focus group discussion. The focus group should be able to accommodate every participant to express their views. The implication is that focus group discussions with many participants are discouraged. The first critical step in initiating the focus group discussion was to explain to the farmers the rationale for the focus group. This included explaining to the farmers the benefits of engaging in robust dialogue that is critical in assisting them in dealing with the different challenges that they face. Each participant was encouraged to use a pseudo name for the purposes of confidentiality. An icebreaker in the form of a game was done to make the participants relax and gain trust for their group members. A key focus of the focus group discussions was to elicit views from the smallholder farmers on the nature of conservation farming being practiced in Umuza District. This entailed giving farmers the opportunity to explain the process of conservation farming being practiced in Umuza District. The idea was to investigate if farmers who have adopted conservation farming are closely following the principles of conservation farming. The focus group also engaged participants in a robust dialogue to air their views on whether conservation farming is an effective method in increasing agricultural productivity. Participants were asked to highlight the challenges that they are facing in using conservation farming. Essentially, this was critical in identifying the challenges and opportunities on the adoption of conservation farming. Participants also shared their understanding of the role that technology can play of improving the effectiveness of conservation farming. This is critical



because the coming in of the fourth industrial revolution in the form of artificial intelligence and machine learning brings about the need for farmers to embrace technology that is an accelerator in improving any farming system. Ultimately, the focus group discussion empowered the participants to provide their recommendations on how conservation farming can be improved for it to become an effective farming system. This is in line with the participatory approach that considers the views of the local people in providing recommendations in dealing with the challenges that they face. This played an important role in assessing the determinants of conservation farming adoption in Zimbabwe.

Through the focus group discussion the researcher managed to collect stories of most significant change, either positive or negative, from the smallholder farmers. The most significant change story is a process that involves the collection of success or failure story emanating from the grass root level by all stakeholders with the aim of searching for project impact. It should be noted that stories of most significant change do not make use of predefined indicators that include those that can be measured or counted and hence relies on stories from the community to establish change or causality (Davies, 2015) This entailed asking from respondents on smallholder farmers who have livelihoods that have improved through the adoption of conservation farming and those if any with livelihoods that have been negatively affected through the adoption and practice of conservation farming.

### **Benefits of focus group discussions**

- (a) Krueger (1994) argues that the use of focus groups makes it possible to increase the sample size with minimum time and investment in resources. As such the researcher used snowballing sampling in a bid to gather additional valuable data.
- (b) According to Wallen (1996) through focus group discussions the researcher can examine how participants react to each other. This enabled the researcher to infer whether the participants were in agreement or not on the subject that was being discussed. Hence the researcher was able to draw conclusions from the participant's reactions and also get clarity on grey areas raised during the administration of the questionnaire.

### **3.10.3 Interviews**

Face to face interviews were conducted with five agriculture extension officers in the sample. The idea was to validate the information acquired from the smallholder farmers as well as gather objective and valuable information from experts in the agriculture discourse who have more field experience in working with smallholder farmers. Kajornboon (2010) points out that interviews are a method of gathering data through dialogues with individuals. The interview method provides the researcher with the opportunity to collect data which can be easily analysed in a timeous manner. The interview guide unearthed the nature of conservation farming practiced in Umguza District through finding out from the Agricultural Extension Officers their understanding of the nature of conservation farming being practiced by smallholder farmers. Through the interviews, the researcher also established the benefits and challenges on the adoption of conservation farming. This also allowed the Agricultural Extension Officers to provide their own recommendations in dealing with the challenges of adoption. The Agricultural Extension Officers also explained if they are any visible differences in terms of agricultural productivity between farmers using the conventional method and those using conservation farming systems. The researcher also established if the Agricultural Extension Officers are aware of any technologies that can be used to improve the effectiveness and efficiency of using conservation farming in the process providing a platform to scale up agricultural productivity. Finally the interview established from the Agricultural Extension Officers if the practice of conservation farming is suitable for Umguza District and also determined how conservation farming systems can also be modified to suit the context of farmers in Zimbabwe.

#### **Benefits of interviews**

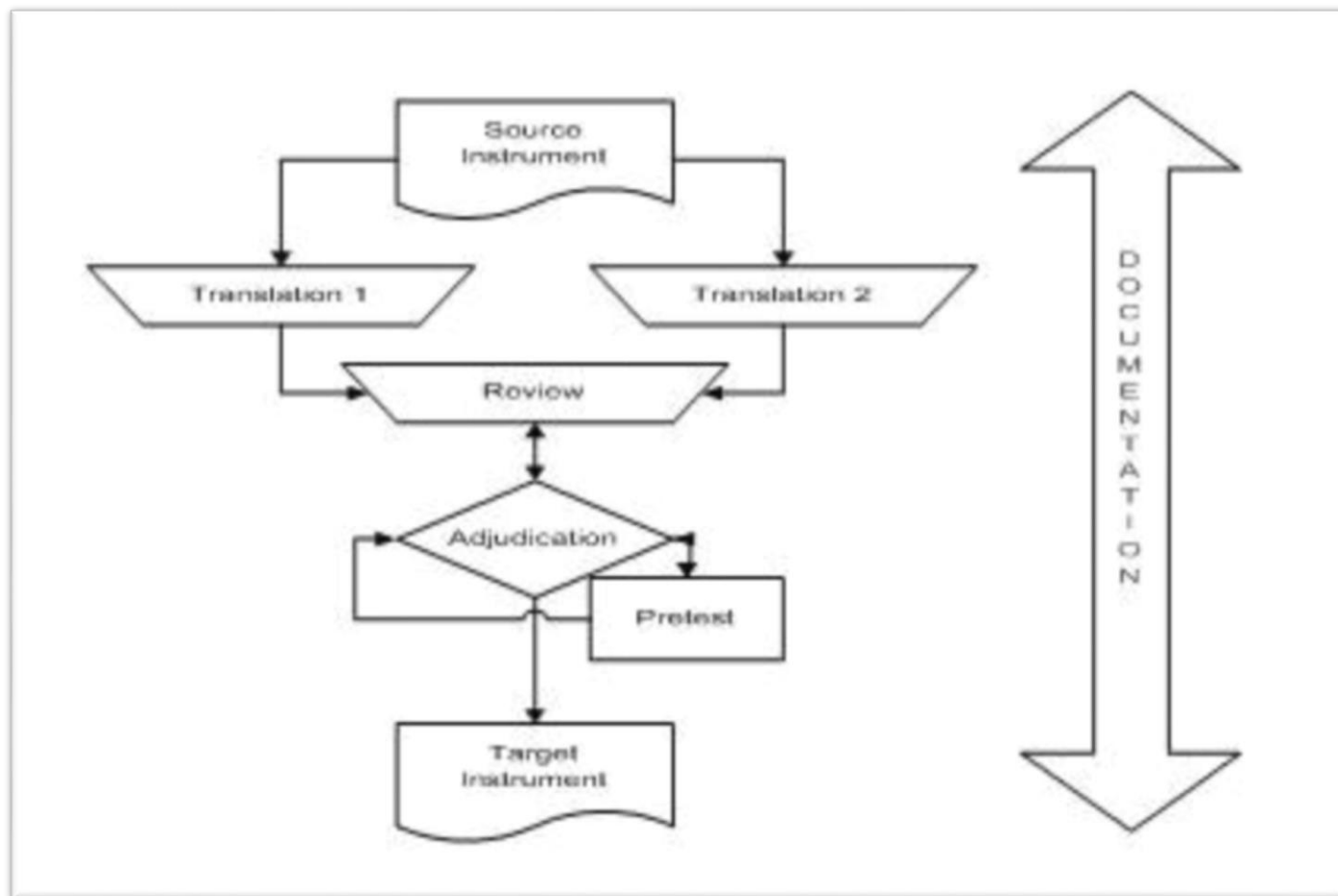
- (a) Interviews provide information about participant's internal meanings and ways of thinking. This made it easy for the researcher to infer on the responses from the extension officers.
- (b) Interviews generally have a high response rate. This enabled the researcher to gather enough data that can be representative of the entire population.

#### **3.10.4 Secondary sources**

In addition to the primary data collection methods, data was also gathered using secondary sources, which comprised mainly reports and registers from the agricultural extension officers. Secondary data provided useful information on farming practices in Umguza District. It was economic to use such data because the information was already available from the local authorities and there was no need to devote resources to this phase of the research. Kothari (2004) notes that it is important for the researcher who uses secondary data to proceed with caution as there is a possibility that the information may not be relevant to the problem that the researcher intends to investigate. Hence the researcher safeguarded the accuracy of data by checking for the reliability, suitability and adequacy of data.

#### **3.11 Translation**

The data collection tools were translated into the indigenous local language - IsiNdebele - to ensure that smallholder farmers who have challenges in understating English fully participate in the study without facing any barriers in terms of language. This entailed the use of team translation in translating the questionnaire and the focus group guide from the English versions to IsiNdebele. Mohler, Dorer, de Jong and Hu (2016) posit that team translation is a recommended approach to translation in comparison to traditional methods of translation that include back translation that fail to comply with the latest translation research.



**Figure3.3: The team translation model**

Source: Mohler et al. (2016:235)

Following the above model the researcher made use of two translators who are trained high school teachers of IsiNdebele. The translations were reviewed by a content writer of an online e learning platform in Zimbabwe. The adjudication was done by an IsiNdebele lecturer from a Teachers' College in Bulawayo. The pre-test of the data collection was done by the researcher during the pilot stage. This ensured that all the necessary adjustments were made before the actual process of data collection began.

### **3.12 Response rate**

The researcher achieved a response rate of 100% to the methods of data collection that were used. This was made possible by the engagement of the community gate keepers on the best time to collect data in a particular day bearing in mind the different activities that communities are committed to participating in. The value of the research was also fully explained to the smallholder farmers so as to ensure commitment and maximum participation in the study. Hand delivery of the data collection tools and collecting them on the same day from the respondents was vital in ensuring a high response rate.

### **3.13 Data analysis strategies**

The researcher made use of thematic analysis to analyse responses from focus group discussions and responses from open ended sections of the questionnaire and interview guide. This ensured that adequate information was captured on recurring themes. This process involved transcribing and analysing data collected according to themes and categories. In order to align with existing guidelines the study made use of Maguire and Delahunt (2017) six steps for analysing qualitative data.

The first step involved familiarization with the data. This entailed reading and re-reading the transcribed data from the focus group discussions, interviews as well as the qualitative responses from the questionnaire.

The second step involved generating codes that were aimed at organizing data in a meaningful and systematic manner. Coding of data was done in relation to its relevance to the research questions. This ensured that data related to specific research questions and research objectives was grouped in distinct segments for easier analysis. When the development of codes was done, transcribed text was then highlighted by different colours which represented a specific research question. Data related to the nature and adoption of conservation farming was highlighted in green, data relating

to the association between adoption of conservation farming and increase in agricultural productivity was highlighted in yellow, with data relating to challenges and opportunities of conservation farming being highlighted in blue and data relating to the determinants of conservation farming adoption being highlighted in red.

Upon completing the process of coding data the researcher examined the codes and translated them to specific themes. In some situations it was possible to have many codes contributing to one major theme related to the research objectives.

The researcher then reviewed the themes to establish if they make sense. This entailed gathering all the data related to each individual theme. The review of the themes was done in relation to how they are feeding into the objectives guiding the study. The researcher made use of the nvivo software to make the process quicker and easier. A write up on the findings of the study was then presented clearly articulating the experiences and perceptions of the smallholder farmers on the effects of conservation farming.

The researcher also made use of quantitative data analysis methods that included the use of the Statistical Packages for Social Sciences (SPSS). This ensured that data was easily quantified in a relatively short space of time and hence making it easier to portray the findings in graphs, pie charts and cross tabulation tables. The process of quantitatively analysing data involved creating a template that captured all the quantitative questions from the questionnaire. The next step involved adding responses from the data collected on to the created template. Quantitative analysis of the measures of central tendency was done to assess the modal responses from the smallholder farmers, the range and the mean average responses. This analysis was also presented in the form of pie charts and bar graphs. Cross tabulations were done to connect responses related to the type of farming adopted and the increase in agricultural productivity, gender and farming experiences as well as rating of agricultural productivity in relation to the Likert Scale in the questionnaire. Student T tests were conducted through the use of the statistical packages for social sciences to assess significant mean output differences in the production of maize between smallholder farmers

making use of conservation farming and those making use of the conventional method of farming. Establishing such a difference was important in understanding the effects of conservation farming.

### **3.14 Ways to ensure validity and reliability**

#### **3.14.1 Validity**

In an attempt to safe guard internal validity, which is the degree to which the results of the study are attributed to the independent variable which is conservation farming and the extent to which the results of the study can be generalized to ensure external validity, the study adopted the use of the natural experiment. Mckenna and Morrison (2010) argue that natural experiments assess a population that would have received an intervention and another one that would have not thus providing the opportunity for a randomized experiment where actual randomization has not taken place which is key in ensuring research validity. The researcher also made a deliberate effort to test for construct validity, test for internal validity, test for external validity and test for reliability. This is because a research which is guided by the case study approach is judged based on the four tests that have been fully explained on the research design section.

#### **3.14.2 Reliability**

In a bid to ensure consistency in terms of the research findings the researcher avoided participant error through ensuring that data was collected during the afternoon when participants had completed their household chores and daily activities that may have affected their full concentration in the process of data collection. Guidance from the traditional leadership was sought with respect to the convenient time to collect data. The researcher also mitigated against participant bias through encouraging the participants to respond to questions truthfully. Time was taken to explain to the participants the value of being honest in their responses. Nkala (2015) explains that through the emergence of various non-governmental organizations that work with

communities, community members have developed a habit of giving responses that they think will help them receive support hence provide inaccurate responses.

Mohajan (2017) notes that reliability is referred to as the stability of findings. Test retest reliability is the process of obtaining the reliability coefficient through repeating the same measure on a second time (Graziano and Raulin, 2006). The rationale is to measure reliability by administering the same test twice over a period ranging from a few weeks to a month. The scores for the two tests are then correlated to establish stability over time, a key measure for reliability (Madan and Kensinger, 2017). The implication is that if the reliability coefficient is high measuring above 0.7 it is considered acceptable and considered very good if it measures above 0.8 (Mohajan, 2017). Thus with the aim of ensuring reliability and consistency of the questionnaire, the researcher conducted a test retest. This meant that after an interval of one month upon completing data collection, the researcher administered the same questionnaire to 10% of the respondents comprising of smallholder farmers in both the control and the treatment groups. This was done through using convenient sampling of smallholder farmers who the researcher was able to get in touch with through transect walks. Guided by the sustainable livelihoods approach capitals, the researcher calculated reliability for question 11 relating to financial capital, question 14 relating to social capital and question 17 relating to human capital. This was aimed at calculating the relationship between the responses in the first test and responses in the second test. Intra class correlation coefficient was used to measure the strength of the relationship in terms of the results produced. This was key in giving the researcher confidence that the measurements obtained are representative and stable over time. Hobbs (2017) explains that without good reliability it is difficult for a researcher to trust that the data obtained is an accurate representation of the respondent's outcomes. The results from question 11 which sought to assess if the smallholder farmers have the necessary financial resources needed for them to become successful farmers had an intra-class correlation coefficient of 0.924. Question 12, which was aimed at establishing if smallholder farmers have a network where they can share their experiences, had an intra-class correlation coefficient of 0.899, while question 17, which was aimed at assessing if smallholder farmers understand the principles of conservation farming having an intra-class correlation coefficient of 0.881. The results from the three tests indicate that the reliability coefficient was



above 0.8 which is considered as very good hence indicating that the findings of the study were stable over time and reliable.

### **3.15 Pilot study and testing of data gathering instruments**

NC3R (2006) conceptualise a pilot test as a research trial intended to examine data collection tools and collect data prior to collecting data from a larger population with the aim of improving the credibility and effectiveness of the methods of data collection. A pilot study was conducted on smallholder farmers in Umguza District. The smallholder farmers were accidentally sampled on the study site in Umguza District. This involved using farmers easier to access by the researcher in the process avoiding travelling costs within Umguza District at the pilot stage of the research. The idea was to cater for the possible mishaps to the questionnaire that was used in the research. Emphasis on the pilot stage was on making sure that everyone in the sample understands the questions in a similar manner. This involved testing the questionnaire in English and the one translated in isiNdebele. Time spent in completing the questionnaire was recorded and this played an important role in guiding the researcher to estimate the real time that was to be taken to complete the data collection process. The researcher also looked out for instances where the smallholder farmers were hesitating or asking for clarification on the questions in the data collection tool. This was an indicator to the researcher on whether the questions were clearly understood by the farmers in a similar manner. Smallholder farmers were also asked to explain how they understood the questions for the purpose of clearly establishing if the correct meaning of the questions was understood. In terms of questions with multiple responses that the smallholder farmers can select from, the respondents were asked to suggest if there are any other responses not included in the questionnaire that could be incorporated as well. The researcher collected feedback from the smallholder farmers through a focus group discussion as well as an informal discussion at the end of the focus group discussion to make the necessary amendments to the data collection instrument.

### **3.16 Ethical considerations**

Ethics in research are norms for conduct that distinguish between acceptable and unacceptable behaviour (Resnik, 2007). In a bid to deal with the ethical dilemma in research, the researcher observed the ethical considerations that have to be adhered to in research. Participants were not subjected to physical and emotional harm. The data collected from the respondents was kept in confidence.

#### **3.16.1 Informed consent**

Informed consent is pertinent to data collection in research. Lahey (2004) defines informed consent as a process of enlightening research participants on the purpose of the research. This also entails informing study participants on the advantages and disadvantages of participating in the study. It is seen as an ethical responsibility for the researcher to ensure that study participants are protected. The idea is to protect participants from any harm that could either be physical or emotional. The researcher briefed the participants on the advantages of the study as it was key in getting consent from the smallholder farmers to participate in the research which was vital in establishing solutions that are instrumental in increasing agricultural productivity. The researcher assured participants of anonymity as data collection tools used did not require any identifiable information from the participants. There are instances where respondents were not willing to divulge information related to government assisted programmes based on their perceived political inclinations. The researcher clearly pointed out to the respondents that information gathered was solely for research purposes and the information gathered will not be directly linked to any of the respondents.

#### **3.16.2 Confidentiality**

Of equal importance in research is the assurance that confidentiality will be maintained during the collection of data. It is critical for research participants who provide data for research either through surveys, focus group discussions or face to face interviews to appreciate how their identities will be used in line with the information they give. (House et al., 1996). The researcher explained that the information gathered was purely for research purposes and was to be recorded

and stored in a safe place. Thus the information recorded was kept safe and participant's names were anonymous. As the researcher was collecting data through the interviews other respondents would inquire from the researcher about the opinions or issues raised by their peers in order to validate their responses. The researcher explained to the respondents that information that was given by their peers was confidential and hence could not be shared with anyone. It was interesting to note that explaining the issue of confidentiality liberated some of the respondents to give more information as they were now fully assured that their confidentiality was taken care of.

### **3.16.3 Anonymity**

Emphasis was placed on the privacy of research participants through ensuring that their names are not written in any of the data collection tools. This was done to ensure that no information will be directly linked to any specific individual. During the focus group discussions there were instances where respondents would call each other using their real identities, and the researcher emphasized on the importance of using pseudonyms in a bid to maintain anonymity of the research participants.

### **3.16.4 Beneficence**

An important element in the collection of research data is the respect for individual and/or group autonomy and privacy (Patton,1990). The principles of beneficence and non-maleficence emphasize the importance of ensuring that participants benefit from the study and are not subjected to any harm. The invasion of privacy issue is important since the use of data gathering instruments that in fact invade respondent's privacy can result in either suspicion or withdrawal by participants from the study. The researcher ensured that participants were protected from potential harm that may have included political risks. This was done through ensuring that the research is cleared by the local authorities at the provincial level of Matabeleland North province. In instances where participants seemed reluctant to participate in the study, the researcher clearly explained the rationale for the study and how participating in the study would be of benefit to the smallholder farmers. This was done in order to ensure that participants benefit from the results of the study as well as learn from the experiences of other farmers.

### **3.16.5 Management of information**

The researcher ensured that the names of participants are not attached to the transcribed notes. Participants were urged to use pseudonyms as they participate in the focus group discussion and interviews. Participants were also advised not to write their names on the questionnaires. All this was done to guarantee the anonymity of the research participants. All the information collected through the research was stored in a safe box that only the researcher has got access to.

### **3.16.6 Debriefing of participants**

The researcher debriefed participants, informing them on how and why they participated in the research. This was vital in explaining to the participants the purpose of the study and to also increase their understanding of conservation agriculture. The researcher administered a debriefing form that highlighted the title of the research and results from the study from farmers practicing conservation farming and those adopting the conventional method of farming. The debriefing provided the platform for the researcher to engage the participants in creating a prototype model of conservation farming based on the findings from the study.

## **3.17 Conclusion**

The chapter has explained and justified post positivism as a research paradigm that was used to inform the research plan. The use of the natural experiment and the case study as research designs that guided the study has been discussed in this chapter. Methods of data collection that were used in the research have been highlighted together with the process of collecting data in the field. The use of quantitative and qualitative data analysis tools has been explained through detailing the steps taken in the analysis of data. The chapter has also explained the ethical considerations that were observed to ensure that research aligns to ethical standards.

## **CHAPTER FOUR**

### **FINDINGS AND ANALYSIS**

#### **4.1 Introduction**

This chapter presents the findings and analysis of this study. The main aim of the study was to assess the effectiveness of conservation farming in improving agricultural productivity against the background of the vagaries of climate change that are affecting the nation of Zimbabwe. Demographic details of the study participants are highlighted as they are critical in analysing the effects of conservation farming as determined by the personal experiences of the smallholder farmers. The research presents cross tabulations where comparisons between key variables in the study are done with the aim of analysing various relationships that affect conservation farming systems. A bivariate analysis of key variables is presented as the study unlocks the relationship between two variables in affecting the effectiveness of conservation farming. A multivariate analysis was also done with the aim of understanding the interaction between multiple variables in comprehending the research phenomenon. Qualitative results are presented in the form of narratives and tree diagrams as the research reflects on the opinions and personal experiences of the smallholder farmers.

## 4.2 Biographical details of the study participants

**Table 4.1: The distribution of the participants by age.**

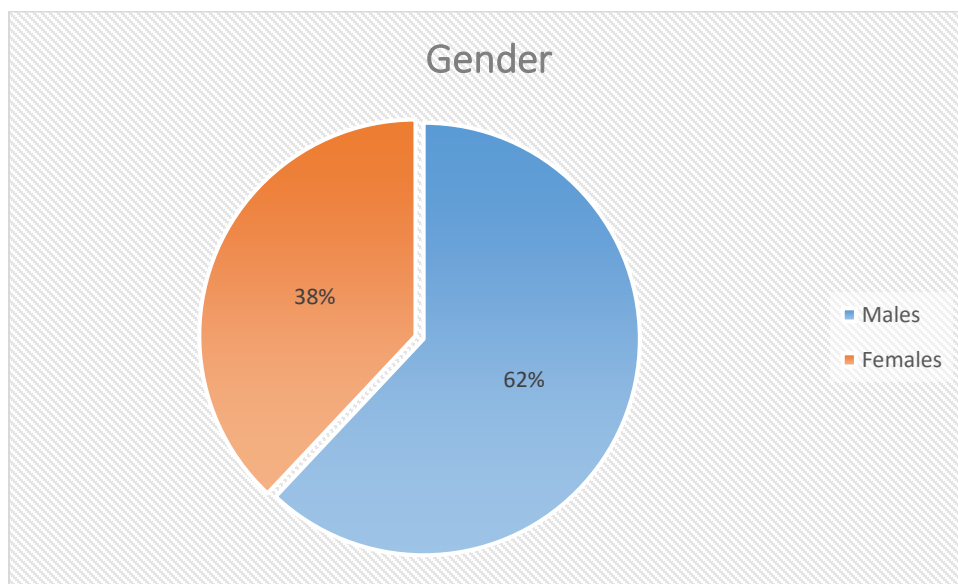
Type of farming approach ^ Age Crosstabulation

Count

		Age					Total
		below 30 years	30-39 years	40- 49 years	50- 59 years	60 years and above	
Type of farming approach	Conservation Farming	1	8	33	6	3	51
	Conventional Farming	0	1	13	20	17	51
Total		1	9	46	26	20	102

Results from Table 4.1 indicate that the 40-49 years age group constituted 45% of the participants in the study hence becoming the modal group in the study. This was followed by the 50-59 years age group that contributed 26% of the study participants with the below 30 years age contributing one percent of the participants into the study. Through this analysis it can be noted that age is playing a key role in determining the type of farming approach adopted by the smallholder farmers. This is because 36% of the respondents comprising of those in the age group 50-59 years old and 60 years and above formed the modal group for farmers using the conventional method of farming as opposed to 32% of the respondents in the age group 40-49 years old who became the modal group in terms of farmers who adopted the use of conservation farming. The findings from the study indicate a preference for the use of conventional farming by those who are aged. The implication is that strategies that are aimed at promoting the use of conservation farming should be targeted at those who are youthful as there seems to be buy in from the younger group of smallholder farmers. Masvongo, Mutambara and Zvinavashe (2016) posit that in developing countries age is usually negatively correlated to education and adoption of different farming technologies. Hence the reason why the older group of the smallholder farmers were the majority

in the group of those who were using the conventional farming approach. Results from the focus group discussions indicate that age plays an important role in determining whether one adopts the use of conservation farming or not. The respondents in the focus group discussions indicated that conservation farming is a method that requires hard work and well bodied individuals and thus can be effectively done by those who are young.



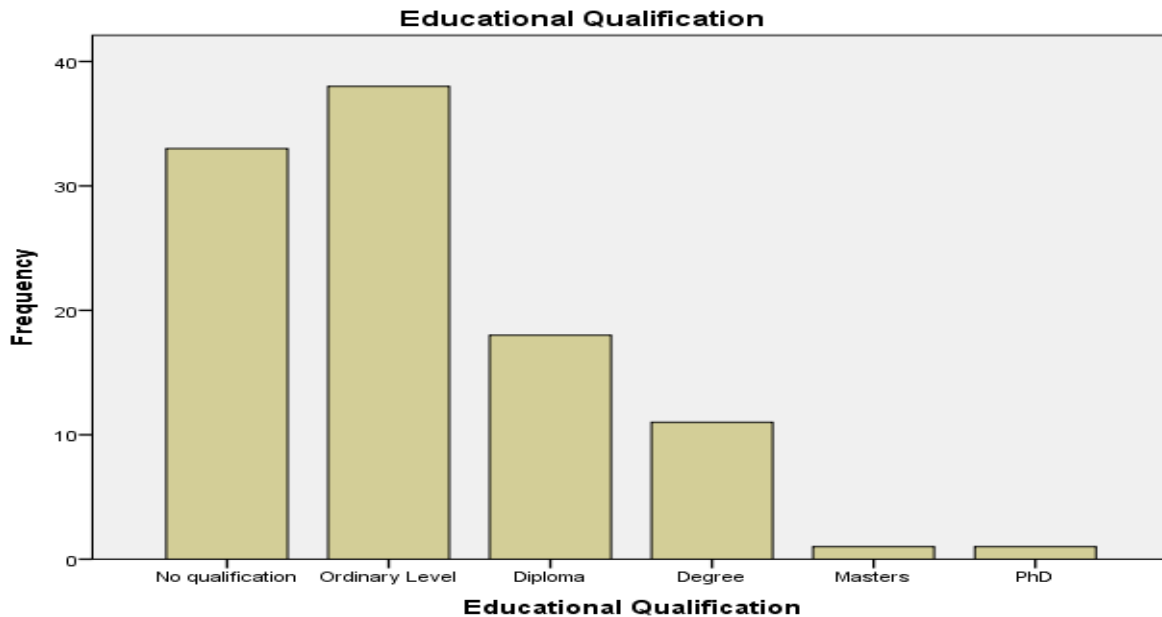
**Figure 4.1: The distribution of the participants by gender**

Results from Figure 4.1 show that the male smallholder farmers constituted the modal group having 62% with the females contributing 38%. The gender imbalance is a reflection of the gendered skewedness in terms of access to land. When reference is made to the diffusion of innovations theory it can be argued that the males are the early adopters in new innovative farming systems as compared to women. This understanding from the diffusion of innovations theory calls for the need for targeted training sessions for women in order to help them appreciate disruptive

farming technologies that can play a role in scaling agricultural productivity. Scoones (2015) argues that an average of 15% to 20% of the communal smallholder plots are recorded as controlled by women. The implication is that the land reform programme has been slow in addressing gender inequalities with regard to the access of land. Mutopo (2016) however posits that land reform has given rise to opportunities for women which can play a role in improving their livelihoods. Of the 37% female smallholder farmers who participated in the study 11% of the participants rated their agricultural productivity as good or average. This is a significant contrast to the 34% of the male smallholder farmers who rated their agricultural productivity as good or average. This is an indication of the challenges that women smallholder farmers are facing as they work towards fighting the vagaries of climate change and aim for providing food security for their households through increasing agricultural productivity.

Results from the study relating to the information that was gathered through focus group discussions show that female smallholder farmers are faced with numerous challenges that relate to gender division of labour which leaves women with the burden of doing multiple tasks at household level. This results in women resisting the use of conservation farming as its processes require a lot of work which burdens women. Okali (2015) points out that women have limited control over the outputs from their labour and therefore lack incentive to increase their production. It is in this regard that gender division of labour places a significant amount of labour ranging from household work to farm work and as a result pushes women away from the factors of production.





**Figure 4.2: The distribution of the participants by educational qualification.**

Results from Figure 4.2 above reveal that the majority of the smallholder farmers in the study were holders of the lowest educational qualification which is the ordinary level certificate contributing 37% with those without any formal qualification contributing 33% and the highest academic qualification which is a PhD being represented by one percent of the smallholder farmers. The indication is that the majority of the smallholder farmers have the lowest academic qualification or do not have any formal education at all. The implication is that the farming expertise of the smallholder farmers in the study was dependent on their day to day experience as communal farmers as opposed to their level of education. According to Krantz (2001) the sustainable livelihoods approach explains that human capital relates to the skills and knowledge that help individuals to thrive when faced with shocks. The implication from the findings is that of a weak human capital that has its skills and knowledge largely based on their experience as smallholder farmers. Agricultural Extension Officers highlighted the need for short courses in agriculture that can be facilitated by technical and vocational institutions within Umguza District. There was consensus that equipping smallholder farmers with technical skills through short courses in technical and vocational training will be vital as a process of investing in their human capital.

Through the focus group discussions participants indicated that limited education also affected the way in which they handled their finances and the ability to access credit from financial institutions. These results further call for the need to also invest in building financial literacy for the smallholder farmers to complement the skills gap emanating from their level of education.

**Table 4.2: Cross tabulation of education qualification and rating of agricultural productivity**

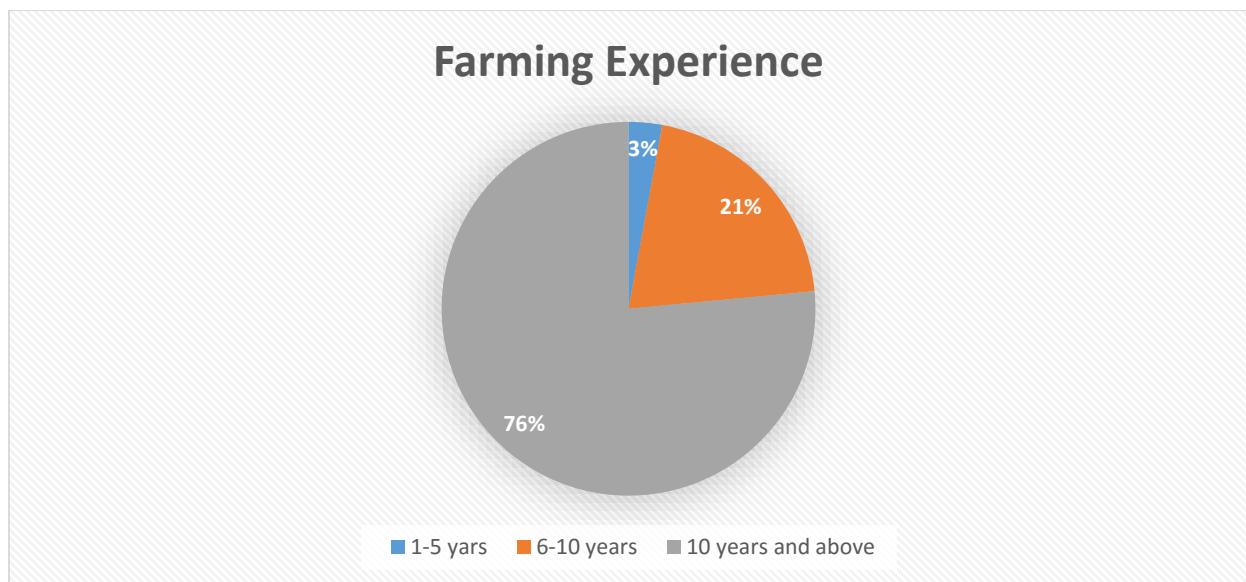
**Educational Qualification \* Agricultural Productivity Crosstabulation**

Count

		Agricultural Productivity			Total
		Good	Average	Below Average	
Educational Qualification	No qualification	1	8	24	33
	Ordinary Level	1	11	26	38
	Diploma	8	8	2	18
	Degree	3	5	3	11
	Masters	0	0	1	1
	PhD	1	0	0	1
Total		14	32	56	102

Table 4.2 above indicates that the majority of the smallholder farmers who rated their agricultural productivity as good were holders of a diploma and a degree respectively. When a comparison is made with those who rated their agricultural productivity as below average it can be noted that the majority in that class consists of those with the lowest educational qualification which is the ordinary level followed by those without any form of qualification. The findings indicate the role played by a smallholder farmer's education in contributing to improved farming outcomes as well as the adoption of expert advice. The results point out to the need to invest in the human capital of smallholder farmers as this is important in empowering smallholder farmers with critical skills and knowledge that will help them to be effective farmers. Musemwa et al. (2013) explain that

education provides the capacity for smallholder farmers to effectively use their resources and the more educated farmers are the more likely they are to have agricultural expertise regarding the use of different farming systems. It is against this background that 16% of the smallholder farmers which is the modal group of those who rated their agricultural productivity as good or average hold a diploma as part of their qualifications. Thirty seven percent (37%) of the smallholder farmers who hold various qualifications indicated that they are making use of conservation farming as opposed to 30% of the farmers who do not hold any form of qualification and are making use of the conventional method of farming.



**Figure 4.3: The distribution of the farming experience of the farmers.**

Figure 4.3 indicates that communal farmers with 10 years and above farming experience contributed 76% of the participants, constituting the modal group, with the 6-10 years farming experience group contributing 21% and the 1-5 years contributing three percent. Lien et al. (2015) argue that smallholder farmers with more farming experience are most likely to be effective and

efficient in their farms despite the different challenges that they may face. An understanding of the farming experience of the farmers is critical in the analysis of the effects of conservation farming as it helps to determine whether vast experience or limited experience is a contributor or not to agricultural productivity. Derpsch and Friedrich (2010) observed that when reliable information on conservation farming is not available from formal support systems that include extension agents, neighbours, or prior experience, farmers may not be able or willing to adopt conservation farming fully, which can lead to disappointing results and subsequent dis-adoption.

**Table 4.3** Cross tabulation of farmer experience and agricultural productivity

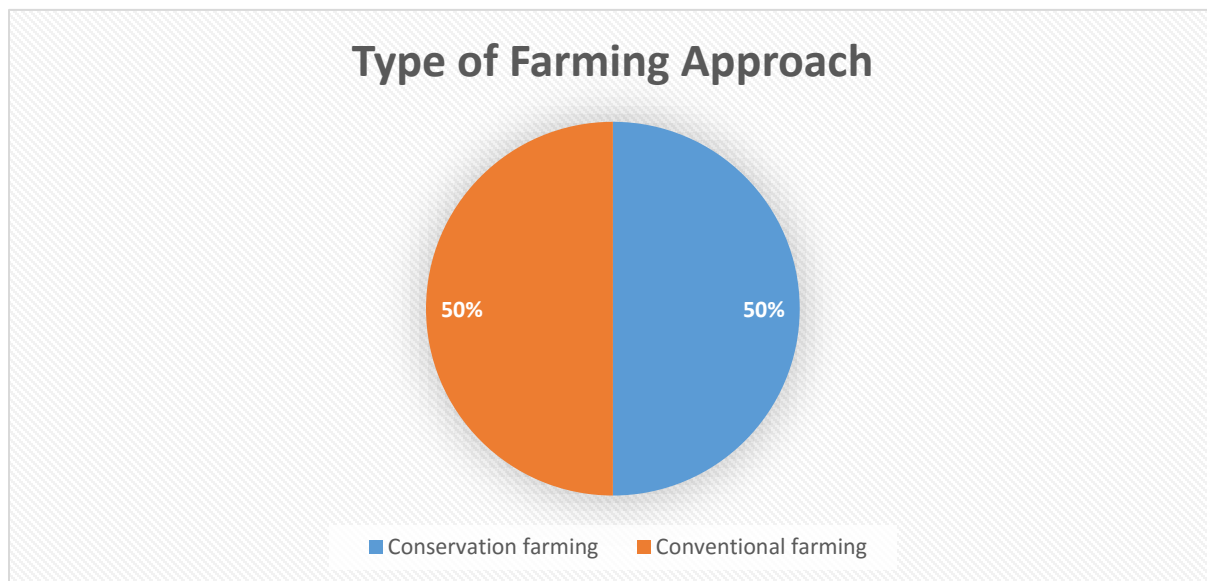
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**No of years as a farmer \* Agricultural Productivity Crosstabulation**

Count

		Agricultural Productivity			Total
		Good	Average	Below Average	
No of years as a farmer	1-5 Years	0	2	1	3
	6-10 years	7	8	6	21
	10 years and above	7	22	49	78
Total		14	32	56	102

Results from Table 4.3 revealed that the modal group of the respondents that constitutes 48% of the participants who have 10 years and above farming experience rated their agricultural productivity as below average. Of the 10 years and above age group 44% are using the conventional method of farming. It should be noted that the 10 years and above farming experience group were also the modal group in rating their agricultural productivity as average contributing 22% of the 31% participants in the study who rated their agricultural productivity as average. The results indicate that the majority of the smallholder farmers who have more farming experience are the bulk in those who are using the conventional method of farming and are also the majority in terms of those who have rated their output harvest as below average. The indication is that farming experience has not played a significant role in improving agricultural productivity for the farmers, instead the type of farming approach adopted in this case conservation farming has been instrumental in improving the output harvest for the smallholder farmers.



**Figure 4.4: The type of farming approach adopted by the smallholder farmers**

Figure 4.4 above shows an equal representation between the farmers adopting conservation farming and those using the conventional method of farming. This is part of the experimental methodology used in the study critical for the comparison of the agricultural outcomes of those using the conventional method of farming and those using conservation agriculture. Focus group discussion respondents explained that smallholder farmers who are still practicing conventional farming are mainly the elderly. This is in line with the results from the questionnaire that revealed that the age group 50-59 years and 60 years and above formed the modal group for farmers using the conventional method of farming. Smallholder farmers highlighted the challenge of limited labour as affecting smallholder farmers in preparing their land. It is important to note 85% of the participants indicated that the use of conservation farming is determined by the health and wellbeing of the smallholder farmers. Gukurume et al. (2016) explain that the use of the hand hoe which is the easily available resource for the digging of planting basins requires strength and endurance to which this is a big challenge for the smallholder farmers as they contemplate on making use of conservation farming.

**Table 4.4 Cross tabulation responses between the type of farming and rating of agricultural productivity**

**Type of farming approach \* Agricultural Productivity Cross tabulation**

**Type of farming approach \* Agricultural Productivity Crosstabulation**

Count

		Agricultural Productivity			Total
		Good	Average	Below Average	
Type of farming approach	Conservation Farming	13	24	14	51
	Conventional Farming	1	8	42	51
Total		14	32	56	102

The results from Table 4.4 present the cross tabulation between the type of farming approach adopted and the rating of agricultural productivity indicating that 25% of the respondents using conservation farming as an approach rated their agricultural productivity as good with 47% of the respondents who are using conservation farming rating their agricultural productivity as average. This is in sharp contrast with participants using the conventional method of farming where two percent rated their agricultural productivity as good with 16% of those who use the conventional method of farming rating their agricultural productivity as average. It should be noted that the modal group of the respondents in the study rated their agricultural productivity as below average and this is a group that is comprised of those who are using the conventional method of farming. Through the focus group discussions the researcher inquired why smallholder farmers were still making use of the conventional method of farming yet their output harvest was very low. Respondents indicated that it is difficult to implement conservation farming based on its demands for hard work. It is interesting to note that respondents highlighted that they are aware that the use of conservation farming can yield good results. One of the respondents referred to the use of conservation farming as “dig and eat” emanating from the belief that for the smallholder farmers to realize the full benefits of using conservation farming, they have to work very hard. Respondents also argued that making a commitment to work hard required smallholder farmers to have access to adequate food that could give them the energy to exert their attention to make conservation farming a success. The implication from these results is that the use of conservation farming is quite difficult in situations of drought.

### 4.3 Analyzing the association between conservation farming adoption and increase in agricultural productivity

**Table 4.5 Independent samples test for the output harvest for farmers who planted 1 hectare area of land in 2014**

	Farming Approach	N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 1 hectare 2014	Conservation	13	1.900	.4378	.1214
	Conventional	13	1.538	.2815	.0781

**Independent Samples Test**

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 1 hectare 2014	Equal variances assumed	6.136	.021	2.505	24	.019	.3615	.1444	.0636	.6595
	Equal variances not assumed			2.505	20.473	.021	.3615	.1444	.0609	.6622

Results from the Table 4.5 above indicate that there was a significant statistical difference in the mean output harvest per hectare of farmer's practicing conservation farming and those using the conventional method of farming. The results indicate that in as much as farmers are experiencing food insecurity those farmers using conservation farming are producing better yields than those using the conventional method of farming.



**Table 4.6: Independent samples test for the output harvest for farmers who planted 1 hectare area of land in 2015**

	Farming Approach	N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 1 hectare 2015	Conservation Farming	13	1.8231	.42652	.11830
	Conventional Farming	13	.9692	.35680	.09896

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 1 hectare 2015	Equal variances assumed	.104	.750	5.536	24	.000	.85385	.15423	.53553	1.17216
	Equal variances not assumed			5.536	23.274	.000	.85385	.15423	.53500	1.17269

In terms of area of land covering 1 hectare in 2015 results from Table 4.6 show that there was a significant statistical difference in the mean output harvest per hectare between farmers using conservation farming and those using the conventional method of farming. This statistical difference in the means is an indicator of the important role that conservation farming is playing in increasing agricultural productivity for smallholder farmers.

**Table 4.7: Independent samples test for the output harvest for farmers who planted 1 hectare area of land in 2016**

Group Statistics

		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 1 hectare 2016	Conservation Farming	13	1.962	.3015	.0836
	Conventional Farming	13	1.338	.5300	.1470

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 1 hectare 2016	Equal variances assumed	4.340	.048	3.684	24	.001	.6231	.1691	.2740	.9721
	Equal variances not assumed			3.684	19.030	.002	.6231	.1691	.2692	.9770

Table 4.7 shows an analysis of the output harvest of maize for farmers who planted an area of land covering 1 hectare in 2016 indicating a continued significant statistical difference in the mean output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming. The differences in the mean of the output harvest of the two farming approaches shows the influence of conservation farming in improving agricultural productivity for smallholder farmers.

**Table 4.8: Independent samples test for the output harvest for farmers who planted 1 hectare area of land in 2017**

Group Statistics										
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean					
Output harvest on 1 hectare 2017	Conservation	13	2.192	.3989	.1106					
	Conventional	13	1.169	.4516	.1253					

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 1 hectare 2017	Equal variances assumed	.007	.936	6.122	24	.000	1.0231	.1671	.6782	1.3680
	Equal variances not assumed			6.122	23.639	.000	1.0231	.1671	.6779	1.3683

Results from Table 4.8 show that in 2017 there was a significant statistical difference in the agricultural output of maize per hectare for those using conservation farming and those using the conventional method of farming. The analysis from 2014 to the year 2017 has shown a steady and continuous significant statistical difference in the agricultural output of maize per hectare for farmers using conservation farming and that of those using the conventional method of farming.

**Table 4.9: Repeated measures analysis of variance for 1 hectare area of land 2014-2017**

<b>Multivariate Tests<sup>a</sup></b>						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	.415	4.264 <sup>b</sup>	3.000	18.000	.019
	Wilks' Lambda	.585	4.264 <sup>b</sup>	3.000	18.000	.019
	Hotelling's Trace	.711	4.264 <sup>b</sup>	3.000	18.000	.019
	Roy's Largest Root	.711	4.264 <sup>b</sup>	3.000	18.000	.019
Time * Approach	Pillai's Trace	.174	1.261 <sup>b</sup>	3.000	18.000	.318
	Wilks' Lambda	.826	1.261 <sup>b</sup>	3.000	18.000	.318
	Hotelling's Trace	.210	1.261 <sup>b</sup>	3.000	18.000	.318
	Roy's Largest Root	.210	1.261 <sup>b</sup>	3.000	18.000	.318

a. Design: Intercept, Approach

Through the multivariate tests in Table 4.9 that were used to analyse whether there are significant differences in the mean output harvest of maize per hectare for smallholder farmers using conservation farming and those using the conventional method of farming on an area of land covering 1 hectare between the period 2014-2017, results have shown a significant statistical difference reflected by the p value of 0.019. The significant statistical difference in the means of the two farming approaches indicates that conservation farming is playing a central role in improving agricultural productivity of maize for smallholder farmers despite the challenges that they may face in making use of the approach.

**Table 4.10: Independent samples test for the output harvest for farmers who planted 2 hectares area of land in 2014**

Group Statistics					
	Farming Approach	N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 2 hectares 2014	Conservation	13	2.177	.5776	.1602
	Conventional	13	2.477	.8526	.2365

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
									Lower	Upper	
Output harvest on 2 hectares 2014	Equal variances assumed		2.349	.138	-1.050	24	.304	-.3000	.2856	-.8895	.2895
	Equal variances not assumed				-1.050	21.098	.305	-.3000	.2856	-.8938	.2938

Results from Table 4.10 show an analysis of the output harvest for farmers who planted an area of land covering 2 hectares in 2014 revealing that there is no significant statistical difference in the mean output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming. The results reflect that smallholder farmers who used conservation farming had no distinct advantage in their agricultural output in comparison to those farmers who used conservation farming.

**Table 4.11: Independent samples test for the output harvest for farmers who planted 2 hectares area of land in 2015**

Group Statistics

Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 2 hectares 2015	Conservation	13	2.692	.7675	.2129
	Conventional	13	2.538	.6475	.1796

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 2 hectares 2015	Equal variances assumed	.871	.360	.552	24	.586	.1538	.2785	-.4210	.7286
	Equal variances not assumed			.552	23.338	.586	.1538	.2785	-.4218	.7295

The results from Table 4.11 show that in 2015, for smallholder farmers who planted an area of land covering 2 hectares there was no significant statistical difference in the mean output harvest of maize per hectare for those who used conservation farming and those farmers who used the conventional method of farming. The results indicate the challenges surrounding smallholder farmers using conservation farming in having a comparative advantage over farmers using the conventional method of farming.

**Table 4.12: Independent samples test for the output harvest for farmers who planted 2 hectares area of land in 2016**

Group Statistics					
	Farming Approach	N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 2 hectares 2016	Conservation	13	2.931	.4990	.1384
	Conventional	13	2.200	.7937	.2201

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 2 hectares 2016	Equal variances assumed	3.219	.085	2.810	24	.010	.7308	.2600	.1941	1.2674
	Equal variances not assumed			2.810	20.204	.011	.7308	.2600	.1887	1.2728

Results from Table 4.12 indicate that in 2016 there was a significant statistical difference in the agricultural output of maize per hectare for smallholder farmers using conservation farming and those using the conventional method of farming. This difference shows a marked improvement from the year 2014 and 2015 where farmers using conservation farming have managed to produce more than those farmers using the conventional method of farming.

**Table 4.13: Independent samples test for the output harvest for farmers who planted 2 hectares area of land in 2017**

Group Statistics

Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 2 hectares 2017	Conservation	13	2.900	.4778	.1325
	Conventional	13	2.108	.8026	.2226

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 2 hectares 2017	Equal variances assumed	2.722	.112	3.058	24	.005	.7923	.2591	.2576	1.3270
	Equal variances not assumed			3.058	19.558	.006	.7923	.2591	.2511	1.3335

Results from Table 4.13 present an analysis of the output harvest in 2017 showing a significant statistical difference in the output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming. This difference shows the substantial progress that conservation farming has played in increasing the agricultural productivity of maize per hectare for smallholder farmers.



**Table 4.14: Repeated measures analysis of variance for 2 hectares area of land 2014-2017**

Multivariate Tests <sup>a</sup>						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	.085	.678 <sup>b</sup>	3.000	22.000	.575
	Wilks' Lambda	.915	.678 <sup>b</sup>	3.000	22.000	.575
	Hotelling's Trace	.092	.678 <sup>b</sup>	3.000	22.000	.575
	Roy's Largest Root	.092	.678 <sup>b</sup>	3.000	22.000	.575
Time * Approach	Pillai's Trace	.287	2.949 <sup>b</sup>	3.000	22.000	.055
	Wilks' Lambda	.713	2.949 <sup>b</sup>	3.000	22.000	.055
	Hotelling's Trace	.402	2.949 <sup>b</sup>	3.000	22.000	.055
	Roy's Largest Root	.402	2.949 <sup>b</sup>	3.000	22.000	.055

In assessing whether there are significant statistical differences in the agricultural productivity of maize per hectare for farmers using conservation and those using the conventional method of farming on an area of land covering 2 hectares , results from Table 4.14 show that there was no significant statistical difference in the output harvest. The implication from these results is that conservation farming did not yield the anticipated results. It was critical for the study to establish why there was no significant statistical difference yet studies across the globe have proved that the use of conservation farming is important in increasing crop yields in contrast to the use of the conventional method of farming. Respondents through the focus group discussions indicated that they are not motivated to make use of conservation farming as the value of using the approach in comparison to using the conventional method of farming is not seen. This is an indication of the negative attitude that smallholder farmers hold towards the use of conservation farming which affects the adoption process and ultimately the effectiveness of conservation farming.

**Table 4.15: Independent samples test for the output harvest for farmers who planted 3 hectares area of land in 2014**

Group Statistics

Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 3 hectares 2014	Conservation	13	3.069	1.1010	.3054
	Conventional	13	2.423	.7259	.2013

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 3 hectares 2014	Equal variances assumed	4.785	.039	1.767	24	.090	.6462	.3658	-.1088	1.4011
	Equal variances not assumed			1.767	20.774	.092	.6462	.3658	-.1150	1.4073

Table 4.15 presents an analysis of the output harvest for farmers who planted an area of land covering 3 hectares in 2014 showing that there was no statistical significant difference in the mean output harvest of maize per hectare for those who used conservation farming and those who used the conventional method of farming. Through focus group discussions it was revealed that in cases where there was no statistical difference for the two groups of farmers, this was due to the failure by smallholder farmers to apply all the important principles underpinning the use of conservation farming based on their unique needs and circumstances.

**Table 4.16: Independent samples test for the output harvest for farmers who planted 3 hectares area of land in 2015**

Group Statistics					
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 3 hectares 2015	Conservation	13	3.323	.8908	.2471
	Conventional	13	2.369	1.0218	.2834

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 3 hectares 2015	Equal variances assumed	.575	.456	2.537	24	.018	.9538	.3760	.1779	1.7298
	Equal variances not assumed			2.537	23.563	.018	.9538	.3760	.1771	1.7306

Results from Table 4.16 presents the output harvest for farmers who planted an area of land covering 3 hectares in 2015 showing a significant statistical difference in the output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming. It is interesting to note that in 2015 there was a significant statistical difference which shows an improvement from the prior year in the same area of land planted.

**Table 4.17: Independent samples test for the output harvest for farmers who planted 3 hectares area of land in 2016**

Group Statistics					
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 3 hectares 2016	Conservation	13	3.285	1.0205	.2830
	Conventional	13	2.277	.6760	.1875

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 3 hectares 2016	Equal variances assumed	1.303	.265	2.968	24	.007	1.0077	.3395	.3070	1.7084
	Equal variances not assumed			2.968	20.830	.007	1.0077	.3395	.3013	1.7141

In 2016 there was an improvement in the output harvest of maize per hectare for smallholder using conservation farming as highlighted in Table 4.17. This is shown through the significant statistical difference in the output harvest for farmers using conservation farming and those using the conventional method of farming. This improvement is attributed to the experience that smallholder farmers now had in the implementation of conservation farming systems. The results suggest that experience and continuous training in implementing conservation farming systems is vital in improving the effectiveness of conservation farming.

**Table 4.18: Independent samples test for the output harvest for farmers who planted 3 hectares area of land in 2017**

Group Statistics					
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 3 hectares 2017	Conservation	13	4.085	.8325	.2309
	Conventional	13	2.477	.8964	.2486

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 3 hectares 2017	Equal variances assumed	.311	.582	4.738	24	.000	1.6077	.3393	.9074	2.3080
	Equal variances not assumed			4.738	23.870	.000	1.6077	.3393	.9072	2.3082

An analysis of the output harvest for those farmers who planted an area of land covering 3 hectares in 2017 is showing a significant statistical difference in the output harvest of maize per hectare for smallholder farmers who used conservation farming and those who used the conventional method of farming as reflected in Table 4.18. On average farmers who planted an area of land covering 3 hectares using conservation farming had a better output harvest than farmers using the conventional method of farming.

**Table 4.19: Repeated measures analysis of variance for 3 hectares area of land 2014-2017**

<b>Multivariate Tests<sup>a</sup></b>						
<b>Effect</b>		<b>Value</b>	<b>F</b>	<b>Hypothesis df</b>	<b>Error df</b>	<b>Sig.</b>
Time	Pillai's Trace	.236	2.270 <sup>b</sup>	3.000	22.000	.109
	Wilks' Lambda	.764	2.270 <sup>b</sup>	3.000	22.000	.109
	Hotelling's Trace	.310	2.270 <sup>b</sup>	3.000	22.000	.109
	Roy's Largest Root	.310	2.270 <sup>b</sup>	3.000	22.000	.109
Time * Approach	Pillai's Trace	.171	1.507 <sup>b</sup>	3.000	22.000	.240
	Wilks' Lambda	.829	1.507 <sup>b</sup>	3.000	22.000	.240
	Hotelling's Trace	.206	1.507 <sup>b</sup>	3.000	22.000	.240
	Roy's Largest Root	.206	1.507 <sup>b</sup>	3.000	22.000	.240

Results from Table 4.19 show an analysis on the output harvest of farmers using conservation farming and those using the conventional method of farming revealing that there was a significant statistical difference for the farmers who planted an area of land covering 3 hectares. This is because farmers using conservation farming managed to produce more than the farmers using the conventional method of farming. It is interesting to note that farmers who planted an area of land covering 3 hectares managed to produce more yet farmers who planted an area of land covering 2 hectares did not have a distinct advantage to those using the conventional method of farming. The results suggest that farm size - whether big or small - does not have a bearing on affecting crop yields through the use of conservation farming. This is because smallholder farmers have indicated that conservation farming is labour intensive and hence would work well on a small area of land, but results have shown that even if area of land planted increases agricultural productivity may also increase.

**Table 4.20: Independent samples test for the output harvest for farmers who planted 4 hectares area of land in 2014**

Group Statistics

Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 4 hectares 2014	Conservation	13	4.254	.6173	.1712
	Conventional	13	1.885	.4525	.1255

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 4 hectares 2014	Equal variances assumed	.242	.627	11.161	24	.000	2.3692	.2123	1.9311	2.8073
	Equal variances not assumed			11.161	22.007	.000	2.3692	.2123	1.9290	2.8094

An analysis of the output harvest in 2014 is showing a significant difference in the output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming as reflected in Table 4.20. The difference shows the instrumental influence that conservation farming has played in increasing the agricultural productivity for smallholder farmers despite the increase in area of land planted.

**Table 4.21: Independent samples test for the output harvest for farmers who planted 4 hectares area of land in 2015**

Group Statistics					
	Farming Approach	N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 4 hectares 2015	Conservation	13	3.931	.9059	.2512
	Conventional	13	3.392	.3968	.1100

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 4 hectares 2015	Equal variances assumed	3.434	.076	1.963	24	.061	.5385	.2743	-.0277	1.1046
	Equal variances not assumed			1.963	16.441	.067	.5385	.2743	-.0417	1.1187

Results from Table 4.21 show the output harvest for farmers who planted an area of land covering 4 hectares in 2015 indicating that there was no significant statistical difference in the output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming. The variation from the prior year in terms of statistical difference is attributed to the El-Nino effects that affected agricultural productivity in the 2015 farming season.



**Table 4.22: Independent samples test for the output harvest for farmers who planted 4 hectares area of land in 2016**

Group Statistics					
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 4 hectares 2016	Conservation	13	4.438	.7654	.2123
	Conventional	13	1.492	.3989	.1106

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Output harvest on 4 hectares 2016	Equal variances assumed	6.356	.019	12.307	24	.000	2.9462	.2394	2.4521	3.4402
	Equal variances not assumed			12.307	18.070	.000	2.9462	.2394	2.4434	3.4490

An analysis of the output harvest for farmers who planted an area of land covering 4 hectares in 2016 shows that there was a statistical significant difference in the mean output harvest of maize per hectare for those who used conservation farming and those who used the conventional method of farming as presented in Table 4.22. This shows a marked improvement from the 2015 farming season that was characterised by severe droughts in the process affecting the effectiveness of conservation farming in improving crop yields.

**Table 4.23: Independent samples test for the output harvest for farmers who planted 4 hectares area of land in 2017**

Group Statistics					
Farming Approach		N	Mean	Std. Deviation	Std. Error Mean
Output harvest on 4 hectare 2017	1	13	4.400	.7853	.2178
	2	13	3.385	.5970	.1656

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Output harvest on 4 hectare 2017	Equal variances assumed	.037	.849	3.711	24	.001	1.0154	.2736	.4507 1.5800
	Equal variances not assumed			3.711	22.398	.001	1.0154	.2736	.4486 1.5822

Results from Table 4.23 showing the output harvest for smallholder farmers who planted an area of land covering 4 hectares in 2017 reveal a significant statistical difference in the mean output harvest of maize per hectare for smallholder farmers using conservation farming and those using the conventional method of farming. The results are a clear indication that conservation farming has been instrumental in improving agricultural productivity despite an increase in the area of land planted.

#### 4.24: Repeated measures analysis of variance for 3 hectares area of land 2014-2017

Multivariate Tests <sup>a</sup>						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	.709	17.903 <sup>b</sup>	3.000	22.000	.000
	Wilks' Lambda	.291	17.903 <sup>b</sup>	3.000	22.000	.000
	Hotelling's Trace	2.441	17.903 <sup>b</sup>	3.000	22.000	.000
	Roy's Largest Root	2.441	17.903 <sup>b</sup>	3.000	22.000	.000
Time * Approach	Pillai's Trace	.826	34.882 <sup>b</sup>	3.000	22.000	.000
	Wilks' Lambda	.174	34.882 <sup>b</sup>	3.000	22.000	.000
	Hotelling's Trace	4.757	34.882 <sup>b</sup>	3.000	22.000	.000
	Roy's Largest Root	4.757	34.882 <sup>b</sup>	3.000	22.000	.000

In summing up the tests on analysing whether there are differences in the agricultural output harvest of maize per hectare for smallholder farmers using conservation farming and those using the conventional method of farming, results have shown a strong significant difference in the output harvest of maize per hectare for farmers using conservation farming and those using the conventional method of farming as presented in Table 4.24. The tests conducted have shown a marked role that conservation farming has played in improving agricultural productivity for smallholder farmers. This is clearly shown through the differences in agricultural output between the treatment group comprising those using conservation farming and the control group comprising those using the conventional method of farming. It should however be noted that the output harvested per hectare by the two groups of farmers is far below standard expectations hence an indicator of the recurrent food insecurity that is affecting Umguza District and Zimbabwe as a whole. Esterhuizen (2015) confirms that most parts of Zimbabwe in the period between 2014-2017 from late January particularly Matabeleland North, Matabeleland South, Masvingo and South of Midlands provinces experienced extreme and hot conditions which affected the bulk of the maize crops that were now at a critical stage of pollination hence resulting in severe wilting and crop loss. The results indicate that although conservation farming came in to assist smallholder farmers cope with the vagaries of climate change associated with erratic rainfalls, the farmers have not been completely spared from food insecurity based on the low agricultural output of maize being produced.

**Table 4.25: Cross tabulation results for the type of farming approach and respondents rating on the state of agricultural productivity for the past 4 years.**

Type of farming approach * Indicate state of agricultural productivity over the past 4 years Crosstabulation							
Count		Indicate state of agricultural productivity over the past 4 years					Total
		very good	Good	Average	Poor	Very poor	
Type of farming approach	Conservation Farming	2	3	20	8	18	51
	Conventional Farming	0	1	11	12	27	51
Total		2	4	31	20	45	102

A cross tabulation of the state of agricultural productivity and the type of farming approach adopted by the smallholder farmers as presented in Table 4.25 has shown that 27% of the farmers who used the conventional method of farming have rated the state of their agricultural productivity as very poor. It should be noted that 18% of those using conservation farming have also rated their agricultural productivity as very poor. The results show that despite adopting the use of conservation farming a significant number of smallholder farmers are producing a very poor output harvest. Majority of the smallholder farmers who use conservation farming rated their agricultural productivity as average. The question that needs to be answered is whether average is enough in the pursuit to increase food production by 70% to feed 10 billion people by the year 2050 (Thierfelder and Siamachira, 2016).

#### 4.4 Analysis of variables affecting conservation farming

**Table 4.26: Cross tabulation of respondents rating on whether they are aware of different technologies and their rating on whether they have the necessary training to practice conservation farming.**

I am aware of the different technology that can be used to scale agricultural productivity			I have the necessary training to practise conservation farming					Total
			Agree	Strongly Agree	Neutral	Disagree	Strongly Disagree	
Agree	Indicate state of agricultural productivity over the past 4 years	very good	1	0	0			1
		Good	2	0	0			2
		Average	1	2	0			3
		Very poor	0	0	3			3
	Total		4	2	3			9
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	very good	0				1	1
		Very poor	1				0	1
	Total		1				1	2
Disagree	Indicate state of agricultural productivity over the past 4 years	Good	2	0	0	0	0	2
		Average	6	7	3	0	0	16
		Poor	1	0	0	1	0	2
		Very poor	11	6	1	0	3	21
	Total		20	13	4	1	3	41
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average	3	2	2	4	1	12
		Poor	4	0	5	8	1	18
		Very poor	11	0	3	6	0	20
	Total		18	2	10	18	2	50
Total	Indicate state of agricultural productivity over the past 4 years	very good	1	0	0	0	1	2
		Good	4	0	0	0	0	4
		Average	10	11	5	4	1	31
		Poor	5	0	5	9	1	20
		Very poor	23	6	7	6	3	45
	Total		43	17	17	19	6	102

The research sought to establish if smallholder farmers were adequately trained to practice the principles of conservation farming with the aim of ultimately increasing agricultural productivity. Table 4.26 shows that fifty nine percent (59%) of the smallholder farmers agreed that they have

received the necessary training to practice conservation. This shows that even those farmers who are using the conventional method of farming have the basic training to practice conservation farming. The results from the study revealed that four percent of the farmers agreed that they have the basic training to practice conservation farming and also agreed that they are aware of the different technologies that can be used to scale up agricultural productivity in the process rating their state of agricultural productivity between very good and average. The results from the study suggest that having access to training and information has not played a great role in influencing the adoption of conservation farming. Through the focus group discussions, the respondents indicated that training does not impact on adoption but largely it is the extent to which the training has been conducted that affects adoption. It is in this regard that results from the study indicate the need for training sessions to be a process and not a once off event if it is to influence the adoption and effective use of conservation farming systems. The conceptual framework used in the study emphasizes the need for innovation knowledge if adoption and effective utilisation of an approach is to take place. The study has revealed that for the innovation knowledge to take place it is critical to continuously provide support and training to smallholder farmers if the opportunities of using conservation farming are to be gained and maintained.

**Table 4.27: Cross tabulation of respondents rating on whether they have the labor needed to assist them in the farm and whether they have the necessary financial resources needed for be successful farmers.**

			I have the necessary financial resources needed to be a successful farmer				Total
			Agree	Strongly Agree	Disagree	Strongly Disagree	
I have the labor needed to assist me in the farm							
Agree	Indicate state of agricultural productivity over the past 4 years	very good	1		0		1
		Good	1		0		1
		Average	2		0		2
		Very poor	0		4		4
	Total		4		4		8
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	very good	1	0	0	0	1
		Good	1	0	0	0	1
		Average	1	3	5	2	11
		Very poor	0	0	2	0	2
	Total		3	3	7	2	15
Disagree	Indicate state of agricultural productivity over the past 4 years	Good			2	0	2
		Average			6	2	8
		Poor			11	8	19
		Very poor			17	7	24
	Total				36	17	53
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average	3		7	0	10
		Poor	0		1	0	1
		Very poor	0		5	10	15
	Total		3		13	10	26
Total	Indicate state of agricultural productivity over the past 4 years	very good	2	0	0	0	2
		Good	2	0	2	0	4
		Average	6	3	18	4	31
		Poor	0	0	12	8	20
	Very poor	0	0	28	17	45	
Total		10	3	60	29	102	

Fifty nine percent (59%) and 28% of the respondents indicated that they disagree and strongly disagree respectively that they have the financial resources needed to be successful farmers as presented in Table 4.27. This constitutes the modal group in the study that has highlighted the aspect of resource constraints as a challenge to the farmers. It should be noted that the majority of the respondents constituting 52% revealed that they do not have the necessary financial resources and the labour needed for them to become successful farmers hence rating the state of their

agricultural productivity as between poor and very poor. The indication from the results is that financial capital as a livelihood capital has an influence in affecting agricultural productivity. This brings out the need to address the access to various livelihood capitals in order to enhance the adoption process and ultimately improve the effectiveness of conservation farming in increasing agricultural productivity.

**Table 4.28: Cross tabulation rating on whether respondents have a network where they can share their experiences with other farmers and on whether they have a conducive climate and favorable weather for agricultural productivity.**

			I have a conducive climate and favorable weather for agricultural productivity				Total
			Agree	Strongly Agree	Disagree	Strongly Disagree	
I have a network where i share my experiences with other famers							
Agree	Indicate state of agricultural productivity over the past 4 years	very good	0	2	0	0	2
		Good	1	1	0	1	3
		Average	2	5	4	9	20
		Very poor	0	0	6	0	6
		Total	3	8	10	10	31
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	Average			0	1	1
		Poor			11	2	13
		Very poor			9	0	9
		Total			20	3	23
Disagree	Indicate state of agricultural productivity over the past 4 years	Good			0	1	1
		Average			2	4	6
		Poor			1	0	1
		Very poor			24	6	30
		Total			27	11	38
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average			1	3	4
		Poor			6	0	6
		Total			7	3	10
Total	Indicate state of agricultural productivity over the past 4 years	very good	0	2	0	0	2
		Good	1	1	0	2	4
		Average	2	5	7	17	31
		Poor	0	0	18	2	20
		Very poor	0	0	39	6	45
		Total	3	8	64	27	102

An assessment on whether smallholder farmers have a conducive climate and favourable weather for agricultural productivity as well as a strong social climate has shown in Table 4.28 that 37%



and 10% of the respondents constituting the majority indicated that they disagree and strongly disagree respectively that they have conducive or favourable weather for agricultural productivity and a network where they can share their experiences with others. This is a clear indication of the challenges faced by smallholder farmers that include unfavourable climatic conditions as well as a weak social capital network that is negatively affecting agricultural productivity, in the process leaving smallholder farmers vulnerable to the vagaries of climate change.

**Table 4.29: Cross tabulation rating of whether respondents receive assistance from the government and whether they have secure land tenure rights.**

			I have secure land tenure rights				Total
			Agree	Strongly Agree	Disagree	Strongly Disagree	
I receive assistance from the government							
Agree	Indicate state of agricultural productivity over the past 4 years	very good	1		0	0	1
		Good	0		0	2	2
		Average	0		1	1	2
		Very poor	0		5	0	5
	Total		1		6	3	10
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	very good	1	0		0	1
		Average	0	1		1	2
	Total		1	1		1	3
Disagree	Indicate state of agricultural productivity over the past 4 years	Average			3	16	19
		Poor			3	11	14
		Very poor			10	13	23
	Total				16	40	56
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Good			0	2	2
		Average			2	6	8
		Poor			6	0	6
		Very poor			7	10	17
	Total				15	18	33
Total	Indicate state of agricultural productivity over the past 4 years	very good	2	0	0	0	2
		Good	0	0	0	4	4
		Average	0	1	6	24	31
		Poor	0	0	9	11	20
		Very poor	0	0	22	23	45
	Total		2	1	37	62	102

Results from Table 4.29 show that 55% and 32% of the smallholder farmers constituting the majority of the respondents revealed that smallholder farmers disagreed and strongly disagreed respectively that they have secure land tenure rights and also disagreed and strongly disagreed respectively that they receive assistance from the government. The results indicate the limited role that the state is playing in supporting smallholder farmers. In a similar study done in Goromonzi by Moyo (2011) results revealed that smallholder farmers doubted the security of their current forms of land tenure, as they deemed their current land tenure to be either too vague or tenuous because of the absence of formal land permits and 99 year leases. The new institutional economics theory outlines that in as much as farmers are viewed as rational beings there is need for institutions in the market that will support smallholder farmers. The limited role that the state is playing in assisting smallholder farmers is evidence of weak institutions in place to support smallholder farmers. This brings out the need to strengthen institutions that will go a long way in helping smallholder farmers have access to resources that will enable them to effectively implement conservation farming systems and in the process improve agricultural productivity.

**Table 4.30: Cross tabulation results of respondents rating on whether they understand the importance of using conservation farming and whether they understand the principles of conservation farming.**

			I understand the principles of conservation farming				Total
			Agree	Strongly Agree	Disagree	Strongly Disagree	
I understand the importance of using conservation farming							
Agree	Indicate state of agricultural productivity over the past 4 years	Good	3	0	0	0	3
		Average	19	1	1	0	21
		Poor	6	0	5	0	11
		Very poor	23	5	0	3	31
	Total		51	6	6	3	66
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	very good	2				2
		Good	1				1
		Average	2				2
	Total		5				5
Disagree	Indicate state of agricultural productivity over the past 4 years	Average	0		7	0	7
		Poor	0		9	0	9
		Very poor	1		4	2	7
	Total		1		20	2	23
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average			1	0	1
		Very poor			0	7	7
	Total				1	7	8
Total	Indicate state of agricultural productivity over the past 4 years	very good	2	0	0	0	2
		Good	4	0	0	0	4
		Average	21	1	9	0	31
		Poor	6	0	14	0	20
	Total		24	5	4	12	45
Total			57	6	27	12	102

Table 4.30 shows that sixty one percent (61%) of the participants noted that they agree and strongly agree that they understand the principles of conservation farming and the importance of using conservation farming. Twenty eight percent (28%) of the 60% of the smallholder farmers who indicated that they understand the principles of conservation farming and the importance of using conservation farming indicated their state of agricultural productivity as poor and very poor. The indication is that an understanding of the principles of conservation farming and the importance of using conservation farming does not guarantee that smallholder farmers will have an increase in their agricultural productivity.

**Table 4.31: Cross tabulation results of respondents rating on whether they were not coerced into practicing conservation farming and respondents rating on not being sure whether conservation farming is an effective farming method.**

			I am not sure whether conservation farming is an effective farming method				Total
			Agree	Strongly Agree	Disagree	Strongly Disagree	
I was not coerced into practicing conservation farming							
Agree	Indicate state of agricultural productivity over the past 4 years	Good		0	3	0	3
		Average		0	20	0	20
		Poor		6	0	5	11
		Very poor		1	3	5	9
		Total		7	26	10	43
Strongly Agree	Indicate state of agricultural productivity over the past 4 years	very good			2	0	2
		Good			1	0	1
		Average			2	0	2
		Very poor			6	1	7
		Total			11	1	12
Disagree	Indicate state of agricultural productivity over the past 4 years	Average	7	0	1	0	8
		Poor	0	3	6	0	9
		Very poor	10	3	0	16	29
		Total	17	6	7	16	46
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average			1		1
		Total			1		1
Total	Indicate state of agricultural productivity over the past 4 years	very good	0	0	2	0	2
		Good	0	0	4	0	4
		Average	7	0	24	0	31
		Poor	0	9	6	5	20
		Very poor	10	4	9	22	45
		Total	17	13	45	27	102

Results from Table 4.31 revealed that seventy one percent (71%) of the respondents indicated that they disagree and strongly disagree to the suggestion that they are not sure whether conservation farming is an effective farming method. This question was deliberately included so as to check for consistency in terms of the respondents' responses as the question is linked to the question that sought to find out if respondents understood the importance of using conservation farming. This serves as a critical measure for reliability with regard to the findings of the study.

**Table 4.32: Cross tabulation of respondents rating on whether they can easily access loans from the bank and if they can afford the cost of hiring and maintaining farm laborers.**

			I can afford the cost of hiring and maintaining farm laborers			Total
I can easily access loans from the bank			Agree	Disagree	Strongly Disagree	
Agree	Indicate state of agricultural productivity over the past 4 years	very good	2			2
		Good	1			1
		Total	3			3
Disagree	Indicate state of agricultural productivity over the past 4 years	Good		3	0	3
		Average		20	4	24
		Poor		4	11	15
		Very poor		18	1	19
		Total		45	16	61
Strongly Disagree	Indicate state of agricultural productivity over the past 4 years	Average		7	0	7
		Poor		0	5	5
		Very poor		9	17	26
		Total		16	22	38
Total	Indicate state of agricultural productivity over the past 4 years	very good	2	0	0	2
		Good	1	3	0	4
		Average	0	27	4	31
		Poor	0	4	16	20
		Very poor	0	27	18	45
		Total	3	61	38	102

Study results as presented in Table 4.32 show that ninety seven percent (97%) of the smallholder farmers indicated that they disagree and strongly disagree that they can afford the cost of hiring and maintaining farm labourers and that they can easily access loans from the banks. The aspect of failing to access loans from the bank is a challenge that is rooted from the weak tenure system where smallholder farmers were given offer letters as proof of ownership of the land. However banks are rejecting offer letters as collateral and hence smallholder farmers fail to get access to loans and as a result have no support mechanism to improve their agricultural productivity.

#### **4.5 Understanding on conservation farming systems and the process of implementing conservation farming**

Eighty five percent (85%) of the respondents demonstrated that they comprehended the concept of conservation farming. Sixty five percent (65%) of the smallholder farmers could make reference to all the principles of conservation farming in a brilliant way; eight percent of the respondents managed to make reference to some of the principles of conservation farming and five percent of the participants managed to indicate a comprehensive understanding of the principles of conservation farming, despite the fact that they were making use of the conventional method of farming. Twenty two (22%) of the smallholder farmers were not in a position to articulate what conservation farming is. All the respondents who demonstrated comprehension of conservation farming could make reference to conservation farming principles that incorporate digging planting basins, utilization of fertilizer and winter ploughing, application of manure and the utilization of harvest deposits for soil cover. It ought to be noticed that a comprehension of the principles of conservation farming does not identify with appropriate use of conservation farming and increase in agricultural productivity. This is because 85% of the smallholder farmers revealed that they have an understanding of conservation farming yet just (50%) of the respondents were utilizing this farming approach.

From these results, it would appear that institutions empowering smallholder farmers with information and knowledge on conservation farming have been effective in equipping smallholder farmers with knowledge on conservation farming principles. Majority of the respondents from the focus group discussions indicated that they have an understanding of the principles of conservation. It should however be noted that although respondents indicated that they have an understanding of the principles of conservation farming, there is need for retraining as the farmers are finding it difficult to practically apply the principles in their day to day activities. Results from the focus group discussion point out that some of the principles underpinning the use of conservation farming that include mulching are not highly practiced in Umguza District. This is because smallholder farmers in the area face a wide range of challenges that include failure to access inputs that include grass and stover.

An intriguing finding was that 74% of the respondents uncovered that there is excessive competition for the utilization of mulch that includes grass and stover, as it is also utilized for thatching and stock feed. Respondents explained that Umguza District lies in agricultural region 5 which they described as a dry area and as such the entire leaves, grass and stover are used for feeding their livestock. This again means there is competition to use mulch for conservation farming and also use it for stock feed. It is in this regard that smallholder farmers are left with the dilemma to either use the mulch for conservation farming or use it for feeding their livestock. Haggblade and Tembo (2015) argue that in Africa conservation farming technology adoption varies due to disparities in weather and rainfall patterns as is the case with Umguza District. Focus group discussions also revealed that lack of standard fencing is also a contributing factor to the shortage of mulch. The modal group of the smallholder farmers indicated that the majority of smallholder farmers lack proper fencing in their farming plots to an extent that livestock consume almost all of their fodder or stover. This becomes a great challenge because most of the farmers are the ones who do not own any livestock and usually rely on conservation farming as a means of their livelihood.

**Table 4.33: Principles of conservation farming adopted by smallholder farmers.**

Principles of Conservation farming	Number of farmers adopting Conservation farming principles	Percentage of the total farmers adopting Conservation farming principles
Winter weeding	12	24
Digging of planting basin	50	100
Mulching	14	28
Manure application	31	62
Basal fertilizer application	25	50
Top dressing fertilizer application	29	58
Early weeding	41	82
Crop rotation	13	26

Table 4.33 shows the principles of conservation farming as practiced by smallholder farmers in Umguza District. The Table indicates that the conservation farming principles that came up in the study as the top priority for the smallholder farmers include the digging of planting basins and the plucking of weeds. Eighty-one percent of these respondents highlighted that they apply these two principles and this may be related to the availability of resources like hoes for potholing and the availability of labour for weeding. Fifty percent (50%) and 58% of the smallholder farmers indicated that they make use of top dressing and basal fertiliser application respectively. Findings indicate that smallholder farmers fairly practice these principles, although not all farmers are applying them. The focus group discussion respondents revealed that most of the smallholder farmers lack capital for buying inputs that include fertilizer and seeds and hence they end up delaying to plant their crops. Esterhuizen (2017) explains that agricultural inputs in the form of maize seed, fertilizer and agro chemicals are in abundance in the market, however there has been low buying power by the smallholder farmers due to delayed payments by the grain marketing board for those who sell their produce as well as the tight liquidity situation in the country. The explanation for this outcome could also be the cause for the fair percentage of the application of manure where 62% of the farmers indicated that they apply manure.

Results from the study show that there are three principles of conservation farming that are seldom used by smallholder farmers in Umguza District and these principles include winter weeding, mulching and crop rotation. Winter weeding with 24% is the least practiced principle of conservation farming by smallholder farmers, followed by mulching with 28% and lastly by crop rotation with 26%. Results from interviews with Agricultural Extension Officers revealed that farmers are used to their conventional farming practice and hence it takes time for them to fully adopt the use of principles such as crop rotation. Agricultural Extension Officers pointed out that mulch was a challenge to the communal farmers, as they often use most of their Stover to feed their livestock. They further underscored that at times smallholder farmers are reluctant to gather tree leaves and grass to be used for mulching and hence most of their mulching is not up to the expected standard.



Results from study reveal that smallholder farmers indicated that crop rotations as a principle of conservation farming may not be universally applicable to all communities. The basis of this argument was that they only receive rains once a year during the rainy season and as such do not have any access to water that includes irrigation water. Thus it becomes difficult for them to then plant crops all year round. Respondents also indicated that the use of crop rotation and winter weeding implies that they have to invest a considerable amount of their time on planting crops all year round yet they have other means of sustaining their livelihoods that they are committed to.

It was noted through the focus group discussions that between the periods July up to the end of October 70% of the smallholder farmers are normally involved with food for assets ventures, mainly implemented by non-governmental organizations to help communities benefit from food aid. It would seem that failure in mulching and delay in winter weeding is not interlinked with the participatory approach. Harfold and Breton (2009) argue that participatory approach empowers smallholder farmers to contemplate and come up with answers to their peculiar challenges. However smallholder farmers' participation in conservation farming seems to be cosmetic than genuine, as they spend most of their winter time in other livelihood sources that include food for assets or food for work.

#### **4.6 Benefits of adopting chosen type of farming approach**

Forty five percent (45%) of the respondents making use of conservation farming clarified that conservation farming enables farmers to prepare their land early and in this manner giving them high chances of expanding their produce due to early planting. The respondents clarified that there has been an expansion in inconsistent rainfalls, particularly as from the 21st century making it exceptionally troublesome for smallholder farmers to depend on ordinary rainfall for their crops. Respondents likewise demonstrated that smallholder farmers will in general have higher produce than smallholder farmers who fail to prepare their land on time. Respondents revealed that the preparation of land when using conservation farming should start immediately after reaping as this

provides an enabling environment for smallholder farmers to prepare their land for conservation farming in alignment with the principles guiding the use of conservation farming.

#### **4.6.1 Increase in crop yields**

Increase in crop yields was cited by 45% of the respondents as a critical benefit of using conservation farming. Respondents through the focus group discussions explained that in as much as the practice of conservation farming is difficult, making use of the approach does have its benefits. Agricultural Extension Officers revealed that there is no doubt conservation farming is crucial in providing an enabling environment for crops to thrive especially in areas that are affected by dry weather conditions and droughts. Increase in crop yields emanates from the other benefits related to the use of conservation farming that include improving the fertility of the soil, preserving the moisture of the soil and the deliberate effort to take care of weeds . All these other benefits emanating from the use of conservation farming result in an increase in agricultural productivity, which in turn provides income increase for smallholder farmers with the ultimate impact being the improvement of the rural livelihoods of smallholder farmers.

#### **4.6.2 Improves fertility of the soil**

Through the use of principles such as crop rotations and mulching, the fertility of the soil is improved which lays fertile ground for improving agricultural productivity. Respondents agreed that a major advantage of using conservation farming was that the approach takes a leading role in improving soil fertility. Farmers indicated that soil is their key focus and biggest resource and hence needed a farming approach that enhances the fertility of the soil. Agricultural Extension Officers explained that making use of crop rotations with nitrogen fixing crops that include legumes is essential in providing nitrogen naturally to the soil which is vital for the process of photosynthesis for the crops. Smallholder farmers also pointed out that the soil is crucial in managing resilience of crops particularly at a time like this that climate change is taking a toll in affecting agricultural productivity, this is through maintaining soil structure and keeping the organic matter in the ground in contrast to the conventional method that exposes the soil and ultimately degrades it hence being termed a climate smart farming approach. The Agricultural

Extension Officers however contended that every farm and soil is different and hence farmers need to understand the uniqueness of their soil and how farmers can better implore principles that enrich their specific type of soil. All this brings the need for farmers to learn from each other to assess the fertility of the soil and the need for patience as it takes time for soil to develop and be fertile. The implication is that the benefits of conservation farming are long term.

#### **4.6.3 Provides opportunities for water harvesting**

Agricultural Extension Officers (100%) highlighted the important role that conservation farming plays in providing opportunities for water harvesting. This is made possible by the principle of permanent soil cover which reduces the amount of water that is lost through the process of evaporation. The Agricultural Extension Officers explained that the retention of water through the process of permanent soil cover was important considering the extent to which communities are affected by droughts. The respondents explained that in the 2018-2019 farming season the meteorological department predicted that the country will be affected by the Elnino effects and as such it is critical to ensure that the little water that is received is protected and efficiently used for the crops and this makes it possible for essential soil nutrients such as nitrogen to be preserved through the amount of water that the soil is able to retain. As such conservation farming provides that ability for the smallholder farmers compared to the use of the conventional method of farming, hence a critical benefit, as cited by the respondents. Through the focus group discussions respondents explained that the concept of covering the soil with crop residues is referred to as the use of God's blanket emanating from the spiritual belief and confidence that smallholder farmers have on the use of crop residues in providing incredible benefits such as water harvesting that are instrumental in increasing agricultural productivity.

#### **4.6.4 Water infiltration and retention**

Water retention and infiltration is another critical benefit that emerged in the study relating to the use of conservation farming. Respondents revealed that the principle of minimum tillage that is emphasized in the use of conservation farming provides an enabling environment for the soil to develop an adequate physical structure; thereby promoting an increase in permeability and

enhancing the retention of water rise in the area of root development in the soil and ultimately relating to wide availability of water in the plants as a result of the increase in root exploration. Pan et al. (2018) posit that water availability constitutes a major challenge for the scaling of agriculture, with agriculture across the world consuming an average of 69% of all the water from the major water sources, with industry and mankind consuming the remaining 24% and 75% respectively. It is through this view that water infiltration and retention is a critical component for the survival of crops in a stressful environment perpetuated by the effects of climate change. This indicates an important benefit being provided for by the practice of conservation farming to smallholder farmers.

#### **4.7 Partner organizations supporting farmers**

Respondents were able to name various institutions that include the agricultural extension department and other non-governmental organizations that help them to scale conservation farming. Participants highlighted that partner institutions offer training programs to various smallholder farmers. Focus group discussion participants indicated that the institutions assist smallholder farmers through providing inputs such as seeds and fertilizer as a conservation farming package. Smallholder farmers cited the Foundations for farming an organization that has been influential in training smallholder farmers to make use of conservation farming. Respondents indicated that the Foundations for farming has coined conservation agriculture , farming the God's way with the bid to give hope to farmers that are making use of the approach which has been instrumental in improving agricultural productivity and rural livelihoods. Results from the study indicate that the government and non-governmental organizations have played a role in scaling the training of conservation farming.

#### **4.8 Shifting from conventional to conservation farming**

Through the focus group discussions smallholder farmers who are presently making use of the conventional method of farming were asked if they were enthusiastic about making use of conservation farming. A portion of the respondents revealed that they were totally ready to make use of conservation farming while others indicated that they were somewhat ready with another group showing that they are not willing to make use of conservation farming. Smallholder farmers making use of the conventional method of farming contended that the labour demands associated with the use of conservation farming were restricting them to change their farming approach. Nkala (2016) contends that the reduction in rainfall patterns over the past decade has immensely slowed down agricultural productivity. As a result of the low rainfall that has been experienced, 61% of the respondents indicated that the outcomes of making use of conservation farming have not been significant when a comparison is made to those who are making use of the conventional method of farming hence affecting the adoption and maximum utilization of conservation farming. Respondents further added through the focus group discussions that they were used to their traditional routine of making use of the conventional method of farming hence shifting to the use of conservation farming was a challenge.

#### **4.9 Constraints in the use of conservation farming**

##### **4.9.1 Labor intensive**

Respondents (65%) indicated that conservation farming is a highly labour intensive approach that constrains farmers in terms of adopting the farming approach as shown in Table 4.34. As a result it becomes difficult to make use of the approach due to its demands for labour. Through the focus group discussions it was noted that high migration of energetic farmers to greener pastures in neighbouring countries has contributed to the increased demand for labour in smallholder homesteads. Smallholder farmers through the focus group discussions indicated that demands for labour through the use of conservation farming are high requiring smallholder farmers to dedicate

a great portion of their time preparing their land for conservation farming. The agreement by the smallholder farmers was that aligning their activities to all the recommended principles of conservation farming would require a great investment in manpower in order to effectively implement the principles of conservation farming.

**Table 4.34: Respondents rating on whether they have the labour needed to assist in the farm.**

I have the labor needed to assist me in the farm					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	8	7.8	7.8	7.8
	Strongly Agree	15	14.7	14.7	22.5
	Disagree	53	52.0	52.0	74.5
	Strongly Disagree	26	25.5	25.5	100.0
	Total	102	100.0	100.0	

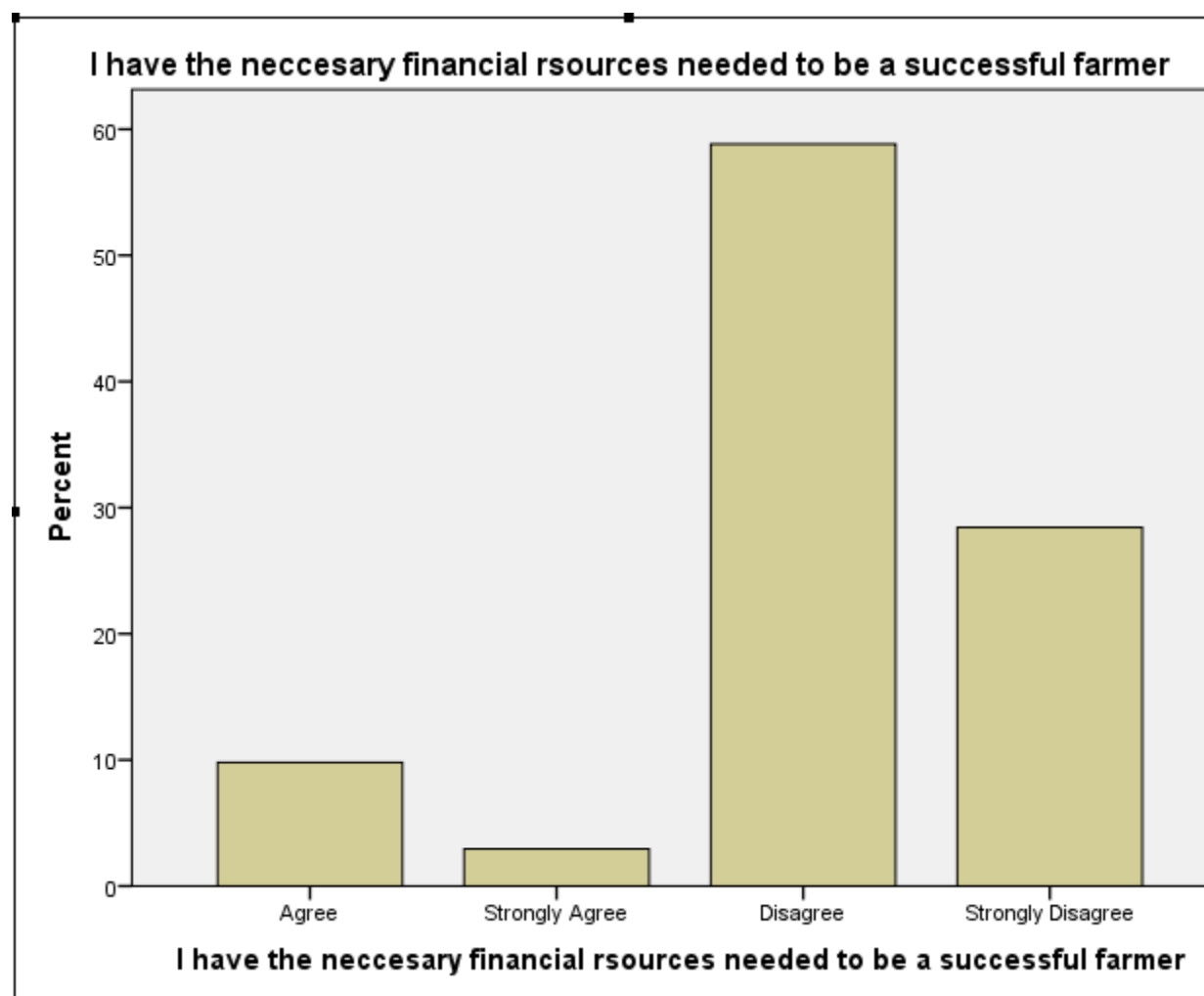
Through the interview, respondents indicated that there are differences in terms of output harvest between farmers using conservation farming and those using the conventional method of farming. The reason behind this is that smallholder farmers perceive conservation farming as labour intensive and as a result do not put full commitment in terms of preparing land and plucking out weeds. The Agricultural Extension Officers indicated that failure to adequately manage weeds is one of the factors that was eliminating the comparative advantage of using conservation farming despite its significant role in preserving soil moisture in areas where there is uneven distribution of rain.

Results from the interviews revealed that due to the Elnino, drought crop residue was consumed by livestock and as a result the land was exposed to heat and water during the off farming season in the process affecting the soil organic ecosystem which is instrumental in enhancing the fertility of the soil. It is in this regard that there was no comparative advantage of using conservation farming over the use of the conventional method of farming hence accounting for the reason why

there are instances where there was no statistical significant difference in the means for the two group of farmers in the study. Through key informant interviews and focus group discussions it emerged that mulch types had different uses and as a result smallholder farmers were left with a mammoth task of finding mulch for the use of conservation farming. This information suggests that smallholder farmers are not fully implementing all the principles of conservation farming and as a result there are thin differences in output harvest of maize for farmers using conservation farming and those using the conventional method of farming. The lack of significant differences is a cause for concern as the use of conservation farming was supposed to bring about better yield outcomes for smallholder farmers as they manage the pressure related with the outcomes of climate change in comparison to their counter parts using the conventional method of farming. Labour challenges that have been highlighted by the smallholder farmers reflect a gap in the human capital for smallholder farmers in Umguza District. UNDP (2015) points out that human capital encompasses the abilities, experience, work skills and the physical state of good health which, when combined allow populations to engage with different strategies and fulfil their own objectives for their livelihoods. Through an introspection of the sustainable livelihoods approach, it is evident that addressing the human capital challenge faced by the smallholder farmers in Umguza District is important in enhancing the effectiveness of conservation farming.

#### **4.9.2 Lack of inputs**

Shortage of inputs critical for the effective implementation of conservation farming was identified by the majority of the participants in the focus group discussions as a constraint that hinders farmers from fully practicing conservation farming. Smallholder farmers posited that it is only possible to effectively implement the major principles guiding the use of conservation farming provided they have the sufficient inputs. Seventy-five percent of the respondents agreed that the economic situation prevailing in the country was making it hard for them to access the necessary inputs needed for them to effectively scale the implementation of conservation. The much needed inputs highlighted included mechanized tractors, digging rippers, fertilizer and seeds.



**Figure 4.5: Respondents rating on whether they have the necessary financial resources needed to be successful farmers.**

Results from the Figure 4.5 above indicate that the majority of the respondents revealed that they do not have the necessary financial resources needed to become successful farmers. This is related to the reason why smallholder farmers are faced with a challenge of accessing inputs. This then negatively affects agricultural activities in the process resulting in farmers failing to increase their



agricultural productivity. The sustainable livelihoods approach emphasizes the need to for smallholder farmers to be endowed with financial capital inorder to stimulate agricultural productivity. Through the results from the study it is evident that financial capital is lacking among the smallholder farmers hence affecting their access to financial resources which are critical in helping them achieve their livelihood objectives of increasing agricultural productivity.

**Table 4.35: Respondents perceptions on whether they can get access to loans from the banks to meet their financial needs.**

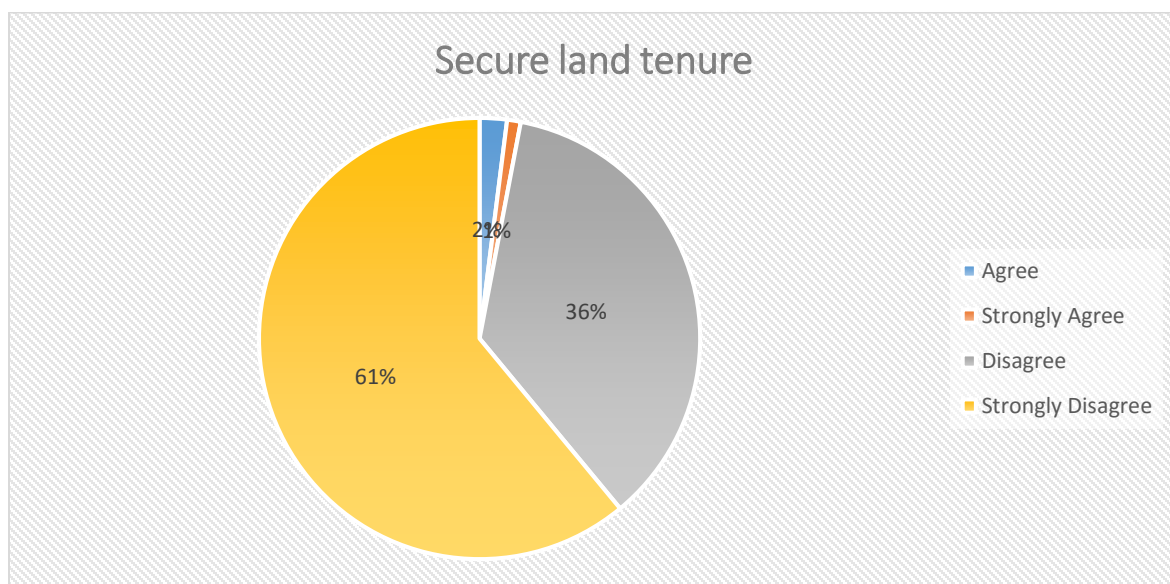
I can easily access loans from the bank					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	3	2.9	2.9	2.9
	Disagree	61	59.8	59.8	62.7
	Strongly Disagree	38	37.3	37.3	100.0
	Total	102	100.0	100.0	

Table 4.35 indicates that the majority of the participants contributing 60% and 37% indicated that they disagree and strongly disagree respectively that they can easily access loans from the bank. Three percent (3%) revealed that they can easily access loans from the bank. Smallholder farmers in the focus group discussions indicated that they do not have access to loans because of the nature of their offer letters that cannot be used as collateral in banks. Gonese et al.(2017) argue that smallholder farmers are faced with a challenge of not being able to access long term loans for implements and other developments due to lack of collateral. It should however be noted that the three percent of the participants who indicated that they have access to loans are part of a group that was established through the influence of a local institution, Steward bank. The participants indicated that the bank is providing loans to smallholder farmers in the area in a partnership with DFID and FAO through a livelihoods and food security programme (LFSP) that aims at improving the livelihoods, food security and nutrition of smallholder farmers as well as rural communities in Zimbabwe. The respondents further indicated that the bank seeks to improve financial literacy among farmers and enhance their access to finance. Respondents have however indicated that there

is resistance among farmers in terms of being part of a group and this resistance emanates from stereotypes and superstitious beliefs emanating from mistrust among smallholder farmers.

#### 4.9.3 Insecure property rights

Insecure property rights came out as constraint that is affecting smallholder farmers in practicing conservation farming.



**Figure 4.6: Results from the study on respondents rating of land tenure**

Results from Figure 4.6 indicate that two percent and one percent of the respondents agreed and strongly agreed respectively that they have secure land tenure rights with the modal group of the respondents contributing 61% and 36% indicating that they strongly disagree and disagree respectively that they have secure land tenure rights. Through the focus group discussions it emerged that insecure land tenure rights was an obstacle for farmers to commit in investing in their farms through conservation farming as they could be evicted at any time. The insecure land tenure rights and the failure by the smallholder farmers to invest in agriculture through using conservation farming is a reflection of lack of trust between the farmers and the government. Participants

indicated that land reform in Zimbabwe has been marred by frequent land invasions that have seen smallholder farmers being displaced from their farms by the politically elite just the way the white commercial farmers were displaced by the state during the fast track land reform programme. The lack of trust among smallholder farmers and the state presents a gap in social capital which should be one of the driving force in promoting agricultural productivity. UNDP (2015) notes that social capital relates to the social resources that include networks, associations and local authorities which the community will depend on as they strive to meet their objectives of achieving sustainable livelihoods. Through reference to the above conceptualisation of social capital as proposed by the sustainable livelihoods approach there is a gap that exists which should be tied by the creation of strong ties between the state and the smallholder farmers with the critical starting point being the allocation of 99 year leases as a form of tenure security.

#### 4.9.4 Limited government support

**Table 4.36: Participants rating on the support they receive from the government.**

I receive assistance from the government					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	10	9.8	9.8	9.8
	Strongly Agree	3	2.9	2.9	12.7
	Disagree	56	54.9	54.9	67.6
	Strongly Disagree	33	32.4	32.4	100.0
	Total	102	100.0	100.0	

Results from Table 4.36 above show that 10% and three percent (3%) of the farmers indicated that they agree and strongly agree respectively that they receive assistance from the government. The majority of the respondents constituting 55% and 32% revealed that they disagree and strongly

disagree respectively that they receive assistance from the government. The results indicate the influence of the neo liberal ideology where the state is not taking a leading role in assisting smallholder farmers, leaving the farmers to function in an unregulated market. Through the focus group discussion participants revealed that government initiatives, that include command agriculture, have only benefited a minority who are linked politically to the state. As a result, the majority of the farmers who deserve to have access to state assistance have not been successful in getting it. Chisango (2018) posits that with the aim of improving agricultural productivity for smallholder farmers through providing opportunities for farmers who do not have access to credit due to insecure property rights, the government of Zimbabwe launched various initiatives that include operation feed the nation, the presidential input scheme and the command agriculture scheme. The initial programs failed to yield the desired results of improving agricultural productivity as the schemes were abused by corrupt government officials at the infancy stage. The results in this study also further indicate that command agriculture has also failed to meet the needs of the smallholder farmers hence rendering as insufficient the support given to the communities by the state, in the process constraining farmers from utilizing innovative approaches such as conservation farming. Smallholder farmers indicated that they would have appreciated a situation where the government assists all the farmers without discrimination based on political patronage. Agricultural Extension Officers pointed out that in as much as the government has the responsibility to assist smallholder farmers, the farmers should not develop a dependency syndrome where everything should be done for them. The Agricultural Extension Officers pointed out that before the fast track land reform programme, majority of the farms that were owned by the whites had important infrastructure that was acquired through the determination of the white farmers to increase agricultural productivity. This view was however rejected by the smallholder farmers who pointed out that white farmers acquired their wealth through the exploitation of the peasant farmers hence the two group farmers could not be compared. The results from the study however continue to indicate that the government has not played its role in supporting the smallholder farmers.

#### 4.9.5 Unavailability of technology

**Table 4.37: Respondents rating on their awareness of different technologies that can be used to scale agricultural productivity.**

<b>I am aware of the different technology that can be used to scale agricultural productivity</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	9	8.8	8.8	8.8
	Stongly Agree	2	2.0	2.0	10.8
	Disagree	41	40.2	40.2	51.0
	Stongly Disagree	50	49.0	49.0	100.0
	Total	102	100.0	100.0	

Study results from Table 4.37 revealed that nine percent and two percent of the respondents agreed and strongly agreed respectively that they are aware of different technologies that can be used to scale agricultural productivity. The modal group of the respondents constituting 49% and 40% strongly disagreed and disagreed respectively that they are aware of different technologies that can be used to scale agricultural productivity. Through the key informant interviews, respondents noted that the understanding of technology is key in ensuring that smallholder farmers realize the full benefits of conservation farming adoption. However this is still a challenge as the majority of the smallholder farmers are uneducated and hence this affects their way of understanding technology, including the primary technological principles underpinning the use of conservation farming. Respondents further added that their failure to understand technology is worsened by the unavailability of technology in their area that can be used to scale conservation farming systems. David (2017) explains that agriculture does not rely much on the natural comparative advantage in farming but is also heavily dependent on an induced comparative advantage built on technological progress and innovation. Farmers in Israel understand and appreciate advanced technologies and as a result are able to make full use of technology as they scale their agricultural productivity through the use of conservation farming (David, 2017).

#### 4.9.6 Dissatisfied with the use of conservation farming

**Table 4.38: Respondents rating on their satisfaction with the use of conservation farming.**

I am satisfied with practising conservation farming					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	5	4.9	4.9	4.9
	Strongly Agree	4	3.9	3.9	8.8
	Disagree	63	61.8	61.8	70.6
	Strongly Disagree	30	29.4	29.4	100.0
	Total	102	100.0	100.0	

A challenge related to the adoption and full utilization of conservation farming by smallholder farmers is the dissatisfaction that smallholder farmers have towards the farming approach. Table 4.38 shows that five percent (5%) and four percent (4%) of the smallholder farmers indicated that they agree and strongly agree respectively that they are satisfied with the use of conservation farming. The majority of the respondents 62% and 29% indicated that they disagree and strongly disagree respectively that they are satisfied with practicing conservation farming.

It is interesting to note that a significant number of smallholder farmers who are using the conservation farming approach indicated that they are not satisfied with practicing conservation farming, this is despite the significant differences in the output harvest of farmers using conservation farming and those using the conventional method of farming as reflected by the students T test conducted in the study. Bakotic (2015) confirms that satisfaction of an approach is directly related to improved performance. The implication is that lack of satisfaction on the use of conservation farming is constraining smallholder farmers to effectively use conservation farming. Through the focus group discussions, the researcher discovered that lack of satisfaction on the use of conservation farming was emanating from the aspect of the approach being labour intensive, particularly the pain that smallholder farmers have to endure when using the hand hoe for digging planting basins. Agricultural Extension Officers hence indicated the need for smallholder farmers to make use of mechanized conservation farming as it reduces the burden that they have to endure

as they implement the farming approach or share the responsibility for labour in the event that machinery is not available.

#### 4.9.7 Involuntary use of conservation farming

**Table 4.39: Findings on whether respondents voluntarily make use of conservation farming**

I was not coerced into practicing conservation farming					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	42.2	42.2	42.2
	Strongly Agree	12	11.8	11.8	53.9
	Disagree	46	45.1	45.1	99.0
	Strongly Disagree	1	1.0	1.0	100.0
	Total	102	100.0	100.0	

Results from Table 4.39 indicate that 42% and 12% of the respondents agreed and strongly agreed respectively that they were not coerced into practicing conservation farming. It is interesting to note that 45% of the respondents indicated that they disagree that they were not coerced into practicing conservation farming. Through the focus group discussions the researcher sought to understand why respondents felt that they were coerced into practicing conservation farming. The participants indicated that Agricultural Extension Officers and organizations that trained the farmers into using conservation farming did not consult the farmers on whether the principles of conservation farming were universally applicable to them. Instead smallholder farmers were told to make use of the approach and were made to understand it as the panacea to the challenges that they are facing in improving their agricultural productivity. The results reflect lack of ownership on the farming approach by the smallholder farmers which negatively affects the effectiveness of conservation farming in increasing agricultural productivity.

**Table 4.40: Cross tabulations on the type of farming approach adopted and respondents' rating on whether they felt coerced into practicing conservation farming.**

**Type of farming approach \* I was not coerced into practicing conservation farming Crosstabulation**

Count		I was not coerced into practicing conservation farming				Total
		Agree	Strongly Agree	Disagree	Strongly Disagree	
Type of farming approach	Conservation Farming	25	8	17	1	51
	Conventional Farming	18	4	29	0	51
Total		43	12	46	1	102

An analysis of the cross tabulation of the type of farming approach adopted and the respondents' rating on whether they felt coerced into practicing conservation farming as presented in Table 4.40 revealed that 36% of the smallholder farmers making use of conservation farming indicated that they were coerced into practicing conservation farming. This may also account for the instances where there were no significant differences recorded in the output harvest of farmers using conservation farming and those using the conventional method of farming basing on the fact that farmers were using conservation farming involuntarily and thus having the potential to affect improvement in agricultural yields. It is in this regard that the perception by the smallholder farmers that they were coerced into practicing conservation farming is now serving as a constraint to the adoption and maximum utilization of conservation farming.

#### **4.9.8 Culture**

The results from the study are showing that culture is playing a role in constraining smallholder farmers in making use of conservation farming. Through the focus group discussions, respondents indicated that culture determines whether or not farmers will adopt the use of conservation farming. For instance there is a strong belief system in the community that maize as it is the staple food in Zimbabwe is only grown during the rainy season and the process of growing maize involves tilling the land in a haphazard manner. This is a way of doing things that is contrary to the principles of conservation farming. Majali (2016) explains that farmers and their families live in a society where there is a certain way of doing things. This is a process that is learnt during



socialization and it becomes a part of their way of living. Harfold and Breton (2009) add that the adoption of conservation farming is a challenge related to the drastic changes that take place when implementing the farming approach which clashes with the habits formed through the use of the conventional method of farming. The resistance that results in the obstacles to the adoption of conservation farming stems from cultural stereotypes that challenge the disregard of the traditional indigenous farming systems. Thus cultural factors become obstacles to conservation farming adoption. Hence smallholder farmers grow up knowing that the only way to plant maize is through first tilling the land and as such they will grow up to believe that it is the only way of planting maize even if the benefits of using other methods are explained. It is because of this that their strongly held beliefs and attitudes may take time to change. This then poses as a serious constraint to the adoption and full utilization of conservation farming by smallholder farmers.

**Table 4.41: Cross tabulation of gender and respondents rating on whether cultural factors negatively affect agricultural production.**

**Gender \* Do cultural factors affect agricultural productivity in your area Crosstabulation**

Count

		Do cultural factors affect agricultural productivity in your area		Total
		Yes	No	
Gender	Male	14	50	64
	Female	25	13	38
Total		39	63	102

The results from Table 4.41 show that 66% of the female respondents indicated that cultural factors negatively affect agricultural productivity with only 22% of the male smallholder farmers confirming that cultural factors negatively affect agricultural productivity. Through the focus

group discussions female participants highlighted that women staying with their husbands usually resist the use of conservation farming because of the cultural expectation that as women they have to constitute the major contributor in providing free service to the farms whilst the men only concentrate on selling the produce. According to Okali (2012) the Moser framework explains that women have triple roles that include reproductive, productive and community roles and this has been central in explaining the work burden that negatively affects women in the process posing as a constraint to the adoption and maximum utilization of conservation farming.

#### **4.9.9 Beliefs and stereotypes**

The study revealed that beliefs and stereotypes related to witchcraft have also played a role in constraining the use of conservation farming among smallholder farmers. Focus group discussion participants indicated that superstitious beliefs related to witchcraft were part of the challenges that affected the adoption of conservation farming. The context came about when respondents indicated that initially when Steward Bank approached the smallholder farmers encouraging them to establish groups so that they could get financing as a group and not as individuals, there was resistance from the farmers. This is because there was lack of trust among smallholder farmers and as a result this led to few groups being formed. Further probing of the participants revealed that some of the smallholder farmers held superstitious beliefs where they believed that other farmers were practicing witchcraft on them hence the reason they are failing to have a good harvest. Agricultural Extension Officers maintained that beliefs and stereotyped views affecting the adoption of conservation farming were also being perpetuated by the non-governmental organisations advocating for the implementation of conservation farming. The respondents pointed out that there are quite a number of non-governmental organisations that have visited their communities advocating for the implementation of conservation farming using Christian labels for the principles of conservation farming. For instance principles such as mulching are being advanced as “God’s blanket”, the process of using conservation farming being termed ‘farming God’s way’ hence portraying the promotion of conservation farming as a method of evangelism. The challenge that has come with advocating for the implementation of conservation farming using the Christian language is that some of the smallholder farmers believe that Christianity was used

to advance colonialism. Hence using the Christian jargon to advance the implementation of conservation farming is perceived as a way of colonising the smallholder farmers the very thing that the post 2000 land reform programme sought to address hence resulting in the resistance to adopt the use of conservation farming. The findings from the study seem to suggest that organisations advocating for the implementation of conservation farming have failed to engage the local communities in a participatory approach hence using a language that is contrary to the beliefs of the local community members to advance the implementation of conservation farming. The dynamics emanating from the beliefs and stereotypes of smallholder farmers call for the need to decolonise the implementation of conservation farming through localising the principles of conservation farming to the local beliefs, stereotypes and needs of the community.

#### 4.9.10 Social capital

Table 4.42: Respondents rating on whether smallholder farmers have a network where they share farmer experiences.

<b>I have a network where i share my experiences with other famers</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	31	30.4	30.4	30.4
	Strongly Agree	23	22.5	22.5	52.9
	Disagree	38	37.3	37.3	90.2
	Strongly Disagree	10	9.8	9.8	100.0
	Total	102	100.0	100.0	

Results from Table 4.42 indicate that the modal group of the participants constituting 37% pointed out that they do not have a network where they can share their farming experience with other farmers. This is an indication that the majority of the smallholder farmers work in silos without a support system to share and learn from other farmers. This is done despite the urgent need for the smallholder farmers to work as a team and harness on social capital in dealing with the labor challenges that they are faced with in the use of conservation farming. As a result this constrains the effective use of conservation farming.

#### **4.9.11 Farm size**

Respondents indicated that the size of their farms deters them from practicing conservation farming. This is because they are still trying to Figure out how conservation farming works and hence they cannot risk committing all their land to conservation farming. The question that smallholder farmers had was that what then happens if all their yields are attacked by weeds as the practice of conservation farming does not allow them to plough their land which is key in controlling and managing weeds as learnt through the practice of the conventional method of farming. This finding relates to that by Mbata, Chapoto and Hichaambwa (2016) who maintain that advocates for the adoption of conservation farming have often focused on increasing conservation farming adoption among households with small farms compared to larger farms yet those cultivating larger pieces of land are more likely to adopt full conservation farming than those cultivating smaller pieces of land. Respondents through the focus group discussions pointed out that they had land constraints and this made it difficult for them to practice crop rotation, which is a requirement for full conservation farming adoption. The findings suggest that the promotion of conservation farming should be tailored to suit the smallholder farmer's landholding sizes.

### **4.10 Enhancing the effectiveness of conservation farming**

#### **4.10.1 Government support**

Through focus group discussions respondents indicated the need for the government to assist smallholder farmers in getting access to inputs. Respondents emphasized the need for access to inputs from the government to be based on merit and not political patronage. Agricultural Extension Officers explained that efforts have been made by the government of Zimbabwe to support smallholder farmers to improve their agricultural productivity. In 2017, the government of Zimbabwe embarked on a special programme referred to as Command Agriculture with the aim of stimulating an increase in agricultural productivity. This is an initiative that was aimed at assisting irrigated and dry land farmers to produce an average of two million tons to cover the

country's yearly requirement for human consumption and for livestock feed. This was a contract arrangement whereby the farmers were given inputs that include fertilizer, fuel, seeds and chemicals. The farmers in turn had the obligation to deliver an agreed amount of maize tons to the grain marketing board as repayment of the loan. The Presidential Input Scheme is another programme that has been used by the government of Zimbabwe to support smallholder farmers. This is a scheme whereby the government of Zimbabwe distributes free inputs that include seed and fertilizer for the production of maize (Esterhuizen, 2017).

#### **4.10.2 Continuous training**

The need for continuous training of farmers on the principles of conservation farming was highlighted as key in enhancing the effectiveness of conservation farming. Respondents through the interview indicated that continuous training of farmers is needed and the process of training should not be an event but a process. Through the focus group discussions, when respondents were explaining the nature of conservation farming in their area, it emerged that some of the smallholder farmers were making use of other principles of conservation farming and leaving out other key principles. This was attributed to the lack of knowledge smallholder farmers have on the whole process of implementing conservation farming. The diffusion of innovations theory clearly highlights that limited information affects how an innovation is adopted and implemented. The implication from the findings of the study is that lack of knowledge on how conservation farming systems work based on limited training are affecting the effectiveness of conservation farming. This brings out the deliberate need for continuous training to enhance the effectiveness of conservation farming.

**Table 4.43: Cross tabulations of type of farming approach and respondents rating on whether they have the necessary training needed for them to practice conservation farming.**

**Type of farming approach ' I have the neccessary training to practise conservation farming Crosstabulation**

Count		I have the necessary training to practise conservation farming					Total
		Agree	Strongly Agree	Neutral	Disagree	Strongly Disagree	
Type of farming approach	Conservation Farming	28	12	8	2	1	51
	Conventional Farming	15	5	9	17	5	51
Total		43	17	17	19	6	102

Study results presented in Table 4.43 revealed that 39% of the respondents who are using the conventional method of farming indicated that they have the necessary training to practise conservation farming. Through the focus group discussions, the researcher sought to establish why smallholder farmers who indicated that they have the necessary training to practice conservation farming were not using conservation farming. Respondents indicated that in as much as they received the training they only hold the basic principles that cannot enable them to go on full scale and adopt the use of conservation farming. It is from this background that the need for continuous training of smallholder farmers on the use of conservation farming is coming out as an important factor in enhancing the effectiveness of conservation farming. Information received from focus group discussions indicates the need for the training on conservation farming to be a continuous process and not an event that is done in just a one day training session.

#### **4.10.3 Knowledge exchange**

Through the key informant interviews, respondents highlighted the need for partner organizations in the agricultural sector to assist farmers to participate in exchange programmes between successful farmers in Zimbabwe, regionally and internationally who are doing well in practicing conservation farming. This knowledge exchange was cited as key in helping smallholder farmers appreciate what success looks like in terms of them adopting and applying all the key principles associated with the use of conservation farming. Munchhausen and Haring (2017) posit that the

core principles of effective knowledge exchange include: first, farmers who are interested in innovative ideas; secondly, relevant and adequate information that must be pitched at a level of knowledge currently held by the farmers; and thirdly, the environment of the information or knowledge exchange which is affected by location and time. The understanding is that when knowledge exchange programs are done for the farmers it is critical that the farmers themselves have an interest in understanding the innovation, in this case the principles of conservation farming. It is also important to take into account their level of knowledge in terms of adoption and utilization of farming systems and the environment in which knowledge transfer takes place. Interview respondents indicated that an environment that encourages farmers to have a first-hand visual appreciation of conservation farming is vital in motivating farmers to take charge and invest significantly in practicing conservation farming. Thus knowledge exchange is instrumental in enhancing the effectiveness of conservation farming.

#### **4.10.4 Social capital**

The results from the interview indicate the important role that social capital plays in enhancing the effectiveness of conservation farming. Respondents revealed that social capital is key in addressing the labour challenges faced by the smallholder farmers who are making use of conservation farming. Respondents pointed out that migration to the urban areas and outside the country in pursuit of employment have resulted in labour shortages considering the demand for labour that comes with the use of conservation farming. Hence with the demands for labour that come with the use of conservation farming, respondents highlighted the need for smallholder farmers to assist each other in their farms. Harnessing on social capital would assist the smallholder farmers in sharing labour through taking the previous approach of the indigenous knowledge systems that advocated for the communal ownership of land and the sharing of labour. This is an indication of the need to share labour and also learn from each other. The platform for smallholder farmers to share their farmer experiences is instrumental in knowledge and skills exchange among smallholder farmers which is vital in ensuring that smallholder farmers correctly apply the principles of conservation farming. Mucheri (2016) explains that social capital acknowledges the importance of collaboration and shared knowledge in creating value for communities. Kilpatrick,

Field and Falk (2003) posit that social capital relates to social relationships that play a role as a resource providing a platform for individuals to collaborate and attain the value of achieving goals in a more efficient and effective way than it would have been if they worked in silos. This explains the critical value of harnessing on social capital to gather social resources in the form of other smallholder farmers and their families to assist in the implementation of conservation farming systems.

**Table 4.44: Cross tabulation of type of farming approach and whether farmers have a network to share their experiences with other farmers.**

**Type of farming approach \* I have a network where i share my experiences with other famers Crosstabulation**

Count

		I have a network where i share my experiences with other famers				Total
		Agree	Strongly Agree	Disagree	Strongly Disagree	
Type of farming approach	Conservation Farming	25	14	12	0	51
	Conventional Farming	6	9	26	10	51
Total		31	23	38	10	102

The results from Table 4.44 above show that the modal group of the respondents contributing 49% in the category of those using conservation farming indicated that they are using conservation farming and also have a network where they share their experiences with other farmers. It is interesting to note that the modal group of those smallholder farmers using the conventional method of farming indicated that they do not have a network where they can share their experience with other farmers. This is a pointer that social capital plays a role in making farmers adopt innovative farming systems, in this case conservation farming.

#### **4.10.5 Participation**

Participation has emerged as critical in enhancing the effectiveness of conservation farming. Through the focus group discussions, respondents highlighted that they are mere recipients of



innovations with no role to play in determining what works for them. One of the respondents noted, “many non-governmental organisations come to us with different projects that we are expected to just implement without considering whether we are capable of doing it and whether we have the suitable environment for implementing the project.” The respondents indicated that they want to be involved in coming up with farming approaches that are aimed at meeting their localised needs, that is, farming approaches that are context specific to their unique environment. Respondents added that in order for interventions to come and meet their unique needs, it is critical for development actors to consult them on what works or does not work. The respondents highlighted that principles such as crop rotations may not work since they do not have access to irrigated water. However, those who have been advocating for the implementation of conservation farming systems are calling for the implementation of all the principles without taking into account what works and does not work. FAO (2017) explains that farmers are active agents who can decide what can or cannot be done on their farms. What farmers decide to do on their farms is determined by various factors that include soil and climate, the information that is available to them, the socio economic situation in their community as well as their own personal situation. The term grass-roots innovation in this sense means the opportunity for villagers to actively choose their farming methods and crops by matching them with their own village circumstances. This clearly shows the need for smallholder farmers to be actively involved in the design of conservation farming approaches that take into account the unique needs of communities which is also key for ownership by the smallholder farmers.

#### **4.10.6 Active role of the private sector in assisting smallholder farmers**

The Agricultural Extension Officers highlighted the need for the private sector to take an active role in assisting smallholder farmers. This is because smallholder farmers are facing challenges in terms of accessing inputs and state interventions can only support just a minority of the farmers. The agricultural extension officer’s highlighted the need for the private sector to step up and engage farmers in initiatives such as contract farming bringing value for the farmers and the private organizations that are offering the assistance. Mazwi et al. (2018) conceptualized contract farming as an agreement entered between smallholder farmers and the private organizations with a set of

conditions attached to it. World Bank (2007) explains that the need for smallholder farmers to make use of contract farming was birthed due to the introduction of structural adjustment programs that resulted in the decline of state support to smallholder farmers with a deliberate focus to promote private investment in the agricultural sector. Champions of contract farming that include the World Bank and the International Monetary Fund view contract farming as a tool that provides mutual benefits to smallholder farmers and private organizations playing a central role in reducing poverty through reversing years of agrarian stagnation in the African continent. It should, however, be noted that as smallholder farmers are encouraged to engage in contract farming so as to improve their access to inputs which is key in enhancing the effectiveness of conservation farming, it is important for the state to ensure that there is a balance of power relations to avoid the exploitation of the smallholder farmers. Opponents of contract farming argue that the contract farming model is based on unequal power relations between the farmer and the private organizations and this results in the exploitation of the peasantry turning farmers into proletariats and giving power to the bourgeoisie (Mazwi et al., 2018). Hence the private organizations need to be engaged to play an active role in supporting smallholder farmers to access inputs and other resources that are important to enhance the effectiveness of conservation farming and ultimately improving food security and livelihoods for smallholder farmers.

#### **4.10.7 Partnerships between likeminded organizations.**

Respondents in the focus group discussion highlighted the need for different organizations that assist farmers to collaborate and engage in projects that complement each other. There was concern by the smallholder farmers that they are occasionally approached by various organizations with some focusing on conservation farming adoption, whilst others are focusing on the adoption of high seed varieties without an emphasis on any specific farming approaches. This leaves farmers with a dilemma in terms of selecting the project and organization to go with. As such, emphasis has been placed on the need for such organizations to partner as this is key in finding lasting and sustainable solutions to the challenges that smallholder farmers are facing and in the process lay fertile ground for enhancing the effectiveness of conservation farming. The development Agenda 2030 calls for multiple stakeholder collaborations that are deliberate in sharing information and

resources with the goal to meet the different priority areas of the sustainable development goals (UN, 2018). This highlights the need for multiple stakeholder partnerships to complement each other's activities that are aimed at promoting agricultural productivity, in the process providing a favourable environment for enhancing the effectiveness of conservation farming.

#### **4.10.8 High yielding seed varieties**

Respondents highlighted the need for farmers to make use of high yielding seed varieties as they make use of conservation farming. Participants indicated that because of climate change, rainfall patterns are unreliable to an extent that during the raining seasons they can stretch to a period of two months without receiving rains. Even if they apply the principles of conservation farming, soil moisture can only be maintained to a certain extent and as a result their crops wither. This is why participants recommended the need to use high seed varieties that are able to mature early, are highly productive and disease resistant. Seed-Co, a local seed company in Zimbabwe, presented a seed maize variety (SC649) that thrives in a stressful environment presented by droughts. The ability of the maize seed variety to thrive in drought environments provides smallholder farmers with the opportunity to produce as much as 16 tons of maize per hectare provided the land has been managed properly (Herald, 2018). Thus if such a seed is utilized in conjunction with the use of conservation farming, farmers may be at an advantage to increase their agricultural productivity as two climate smart approaches are used together to improve or increase agricultural productivity. It is in this regard that high seed varieties of maize are seen as critical in enhancing the effectiveness of conservation farming.

#### **4.10.9 Mechanized conservation farming**

Respondents indicated that mechanized conservation agriculture will go a long way in enhancing the effectiveness of conservation farming. Through a story of most significant change one of the respondents noted "My brother, I have eight hectares of land of which I and my eleven children cannot adequately use especially making use of the hand hoe, we have tried it but the outcomes have not been good". Respondents highlighted the need for the government to assist them to purchase tractors and great quality seeds to empower farmers to increase their agricultural

productivity which is instrumental in improving their livelihoods. Agricultural Extension Officers explained that quite a number of smallholder farmers are affected by the hand hoe driven conservation farming which has in turn perpetuated low yields for the farmers. Agricultural extension officers, however, went on to explain that conservation farming is not as labour intensive as farmers imagine it to be. This is because digging planting basins can be arranged in time before the rainy season begins. Moreover, in the event that planting basins are checked and prepared on time then conservation farming will require less work since farmers can make few new gaps. So too with weeding - if winter weeding is finished prior to digging planting basins, the demands for labour will be reduced as weeds will be minimised from the onset.

#### **4.11 Determinants of conservation farming adoption**

Respondents in the study highlighted various factors that play a role in determining whether smallholder farmers will adopt the use of conservation farming.

##### **4.11.1 Information dissemination**

Respondents indicated that information dissemination plays a central role in determining whether or not smallholder farmers will adopt the use of conservation farming. Information dissemination in this regard is related to availability of information on how conservation farming works, the benefits of using the approach and the possible challenges that smallholder farmers may encounter through the use of the farming approach. Respondents indicated that it is critical for extension officers to continuously provide information to the smallholder farmers bearing in mind that the use of the approach comes with its challenges which in most instances have accounted for the cases of disadoption. Harera and Sain (2015) explain that provision of information through training provides an enabling environment for the adoption and implementation of any farming technology. It can be noted that access to information is a factor that determines the adoption of conservation farming technology. The implication is that the adoption of conservation farming will not be possible if critical information related to the use of conservation farming is not continuously given.

The diffusion of innovation theory explains that without adequate information it will not be easy for individuals to adopt and make use of an innovation (Harrera and Sain, 2015). Smallholder farmers recommended for the active participation of Agricultural Extension Officers in providing information for them as and when needed. Milder et al. (2015) posit that knowledge on conservation farming is not popular around the African continent; this is because it is seldom taught even in specialised agricultural training institutions. In instances where knowledge on conservation farming is shared, the information shared is often divorced from the realities of the local level land management systems.

#### **4.11.2 Personal characteristics**

Through the interviews, agricultural extension officers indicated that individual qualities of different smallholder farmers influence adoption choices. This is on the grounds that conservation farming demands deliberate preparation and proactive implementation of various principles. It demands a shift in mind-set where droughts related with the outcomes of climate change are no longer viewed as a threat to livelihoods but as a chance to innovate and produce more in light of the different challenges experienced. Respondents pointed out that personal characteristics related with the level of education for the smallholder farmers, work motivation, the willingness to learn and be corrected were key in ensuring the effective implementation of conservation farming. The respondents pointed out that for smallholder farmers to be able to effectively implement conservation farming systems, it is important for them to be personally motivated to work hard and achieve their goals. The understanding is that without motivation to work hard and achieve their goals, it would be very difficult to implement conservation farming. The diffusion of innovations theory explains in the persuasion stage that the way an individual is motivated towards accomplishing a task of an innovation will affect the way in which the individuals will deliver on meeting their goals (Sahin, 2006). This confirmation by the diffusion of innovations theory explains why it is important for smallholder farmers to be motivated to work hard as they implement conservation farming. The Agricultural Extension Officers agreed that the level of education of smallholder farmers plays an instrumental role in affecting the way in which the smallholder farmers will adopt innovative agricultural practises introduced to them. A fascinating

finding by Gould et al. (2010) on conservation farming uncovered that more seasoned and more skilled smallholder farmers were more probable to diagnose soil anomalies than their inexperienced smallholder associates. But once diagnosed the probability of the experienced farmers dealing with the problem was lower in comparison to the youthful inexperienced smallholder farmers. This finding suggests that youthful farmers have a role to play in scaling innovative agricultural practises. It should be noted that in this study the youthful farmers were the least in the population of smallholder farmers. This reflects that even though the youthful farmers may have the energy to run with innovative solutions to solve problems faced in the agricultural sector, only a few are committed to invest in agriculture. This calls for the need for the local authorities to encourage the youth to take up agriculture and be in the fore front in implementing innovative agricultural systems.

#### **4.11.3 Risk diversification**

The need for risk diversification emerged as a factor that determines the implementation and maximum utilisation of conservation farming by smallholder farmers. Participants in the focus group discussions who are making use of conservation farming indicated that adoption rates rarely reach 100%. Participants revealed that they have limited resources to take care of their farms through the complete use of conservation farming, however the limited areas in which they do make use of conservation farming, they do so because of the perceived benefit of conservation farming as insurance to the low rainfalls that they may experience. Respondents indicated that they value conservation farming but viewed the practice as a mechanism to protect them in the event that they experience severe droughts. Respondents also highlighted that in as much as they had received training on implementing conservation farming; they had no yet completely grasped the concepts in a way that they would have committed all their land under conservation farming systems. The assumption by the respondents was that having invested much of their farming activities on the conventional method of farming, the use of conservation farming was only perceived as method of diversifying risk in anticipation that if the conventional method of farming does not work then they may get something from conservation farming. Respondents further added that they were venturing into conservation farming because of the commitments that they would

have made with financing schemes such as the command agriculture where they were expected to pay back the inputs given to them through giving a certain percentage of their harvest. Hence such commitments made by the smallholder farmers triggered some of the farmers to engage in conservation farming as means of diversifying risk in the event that they do not get a good harvest through the use of the conventional method of farming. The implication by these findings is that when the state decides to assist smallholder farmers it is critical that the support comes with the conditions to pay back either financially or through a commitment with their harvest. This will go a long way in reducing the dependency syndrome challenge as well as motivating smallholder farmers to try out new methods of farming such as conservation farming as they diversify risk in order to increase agricultural productivity.

#### **4.11.4 Gender roles**

Through the focus group discussions it emerged that unequal gender roles play a critical role in determining conservation farming adoption. Respondents indicated that women have a responsibility to make sure that they prepare the land and take care of the weeds in the field whilst the men have a responsibility for ensuring that they find a market for their produce. From this background conservation farming increases the total time that women spend on agriculture. Participants revealed that women are mostly involved in ploughing, a responsibility that some of them do whilst they are carrying children on their back. This shows the multiple roles that women have to endure and as a result affect the adoption and maximum utilisation of conservation farming. Respondents acknowledged the important role that women play in making the commitment to adopt the use of conservation farming at household level. The results clearly show the importance of gender roles in affecting the decision to adopt and the maximum utilisation of conservation farming.

#### **4.11.5 Health and wellbeing**

Results from the study revealed that the health and wellbeing of smallholder farmers is instrumental in determining conservation farming adoption. Participants indicated that with the practice of conservation farming, farmers have to invest quite a significant amount of their time in

the fields throughout the year and this can only be possible if they are healthy and physically fit. Respondents argued that with the shortage of anti-retroviral drugs affecting the country perpetuated by the prevailing drought, smallholder farmers are negatively affected in terms of implementing conservation farming. One of the respondents noted: “with the current economic situation in the country that is affecting us contributing to the unavailability of food, the shortage of ARVs and the high cost of tablets for blood pressure needed by some of our peers, it is very difficult to make use of conservation farming”.

Respondents further highlighted that some of the smallholder farmers are now old and their health is deteriorating and this makes it challenging for them to commit in implementing conservation farming systems as a lot of hard work is required particularly in the digging of planting basins and the process of weeding. According to Sachs (2018) health in itself is important as a human right but health also contributes to growth and development in different ways. First, in terms of labour productivity, healthier people who are physically and mentally healthy and active can produce more working hours, use technology machinery and equipment more efficiently. Secondly, labour in that good health can reduce the number of sick days for workers improving health can increase productivity and hence lead to incentives to increase the labour supply. Agricultural Extension Officers through the interview explained that they have often experienced resistance when encouraging smallholder farmers to implement conservation farming and the explanation for resistance has been based on the understanding that they do not have adequate food to eat and give them the energy to work on the fields as well as the deteriorating health for some of the farmers. One of the respondents indicated that as a community in Umguza they once experienced a situation where one of the smallholder farmers died whilst working on the fields and the understanding by other smallholder farmers was that the farmer was working too hard yet he was suffering from one of the non-communicable diseases. It is based on this that health and wellbeing of smallholder farmers has a role to play in determining the adoption of conservation farming. This result from the study calls for the need of a study that will extensively assess the impact of non-communicable diseases in affecting smallholder farming. This is research that will be critical in providing sustainable solutions to the health challenges affecting some of the smallholder farmers.



#### **4.11.6 Attitude**

During the interviews, Agricultural Extension Officers explained that the attitude that smallholder farmers hold towards the use and success of conservation farming has a role to play in terms of determining the adoption of conservation farming. Respondents indicated that the formation of positive attitudes towards the use of conservation farming was vital in enabling the effective implementation of conservation farming among their peers. Respondents indicated that the formation of positive attitudes towards the use of conservation requires that the smallholder farmers be continuously trained on the benefits of using conservation farming, be exposed to farmers that have successfully implemented conservation farming with tangible results and also include the smallholder farmers in the design of conservation farming principles localised to their environment. Respondents added that involving the smallholder farmers in the implementation of conservation farming principles was critical in gaining ownership which is important in fostering a positive attitude towards the implementation of conservation farming principles.

Agricultural Extension Officers further highlighted that government support towards the implementation of innovative farming systems was crucial in developing a positive attitude among smallholder farmers to take up innovative farming systems. The findings reflect that smallholder farmers in Umguza District have a negative attitude towards conservation and this negative attitude stems from their isolation in the design of conservation farming systems in their area. The negative attitude towards the implementation of conservation farming systems also emanates from the lack of support from the state. Learning from the success story of South Korea, it was noted that the attitude that farmers held contributed to the successful adoption of different farming technologies and ultimately the success of South Korea. Sachs (2018) posits that the most striking achievement in South Korea was the transformation of villagers' attitudes from frustration and cynicism to a spirit of self-help and 'can-do'. Farmers in South Korea were empowered to develop their own innovation in agriculture to transform their livelihoods and this active participation was key in changing the attitudes that the farmers had towards any form of innovation that they were told of. Hence it is critical to engage smallholder farmers in the development of agricultural policies that meet their unique needs. It is thus critical for the government in Zimbabwe to collaborate with

smallholder farmers through the Agricultural Extension Officers and give the smallholder farmers the opportunity to participate in the design of their own farming systems. Empowering the smallholder farmers will also entail giving them freedom in terms of the distribution and allocation of resources intended for agricultural support. Allowing smallholder farmers to participate in the allocation resources and the design of their localised farming systems will go a long way in contributing to the formation of a positive attitude that will lay the fertile ground for the adoption of innovative technologies such as conservation farming as well as the effective implementation of conservation farming.

#### **4.11.7 Agricultural policy**

Participants indicated that the existence of an agricultural policy that is deliberate on solving food insecurity through supporting smallholder farmers was a key determinant for the adoption of conservation farming. Participants argued that they are not aware of any policy related to agriculture and in the event that the policy is there they do not have an understanding of how it meets their unique needs. The respondents further outlined that in instances where they have seen other farmers benefiting from government support, it is often a support that is based on political patronage. Past strategies were based on political reactions to unfolding situations. Agricultural Extension Officers emphasized the need of an agricultural policy that takes into account the unique contexts of smallholder farmers through engaging the smallholder farmers in the development of such a policy.

The knowledge gap identified in this study is that the current agricultural policy as applied nationwide treats the smallholder farmers as a homogenous group despite their different socio-economic and environmental conditions of their regions. This does not address the issue of food insecurity and the need to increase agricultural productivity when looking at different environmental conditions of different regions in Zimbabwe. Knowler (2015) observed that policy has been a critical driver in scaling the successful implementation of conservation farming in Latin America. Hence the need for a study that will uncover how the agricultural policy can be developed and implemented in a way that meets the different needs of all stakeholders

#### **4.11.8 Regional differences**

Differences in environmental conditions that include the nature of the soil also emerged as a determinant for the adoption of conservation farming. Respondents in the focus group discussions emphasized that villages are unique and hence the principles of conservation farming cannot be universally applied. Respondents from Ward 12 revealed that their ward is situated in a low lying area which is prone to floods. As a result the use of conservation farming may affect crop productivity in the event that in that particular season they are affected by floods. Participants revealed that tilling the land makes it easier to drain water once subjected to floods. The climatic changes that have affected the southern parts of Zimbabwe are characterized by the increase in frequency of floods and droughts that are affecting smallholder farmers (UNDP, 2016). In this case regional differences play a role in determining whether smallholder farmers will adopt the use of conservation farming. This finding is in line with De Harera and Sain (2015) who confirm that the adoption of the use of conservation farming interacts with biophysical factors that include soil type and rain fall patterns. This is because smallholder farms located in regions with steep slopes are most likely to adopt the use of conservation farming.

#### **4.11.9 Access to resources**

Respondents indicated that access to resources plays an instrumental role in determining the adoption of conservation farming. Participants in the focus group discussions revealed that access to various inputs will go a long way in encouraging farmers to adopt the use of conservation farming. Smallholder farmers indicated that a minority of them have access to draught power. Agricultural Extension Officers revealed that mechanized agriculture is a critical driver in increasing conservation farming adoption as it is a method that alleviates the challenge of conservation farming being a labour intensive approach. The challenge that smallholder farmers then have is that only a minority have access to animal drawn no till planter and animal draught power. Hence the only solution for the smallholder farmers is to use the manual hand hoe for digging planting basins, a procedure that is labour intensive. It is in this regard that access to inputs has appeared as a key determinant for conservation farming adoption. Through the use of the

sustainable livelihoods approach it was critical to assess the extent to which smallholder farmers have access to resources which is a variable largely related to the financial capital.

Having an appreciation of the financial capital of the smallholder farmers was instrumental in assessing the level of vulnerability which has a role to play in affecting the effectiveness of conservation farming. UNDP (2015:9) posits that the financial capital is the most versatile of all the five capital as it can be converted with varying degrees of ease depending on the context. The results from the study have shown that the financial capital has a role to play in assisting smallholder farmers acquire resources such as infrastructure for their farms which is related to the physical capital. The financial capital can further empower smallholder farmers to access human capital in the form of labour to work in the farms. The financial capital can further regulate access to land and water which is related to the natural capital. All these connections presented by the financial capital indicate that access to resources which is a product of financial capital has an important role to play in determining the adoption of conservation farming. The findings indicate the important need for various partners to come on board and assist smallholder farmers in accessing financial capital that can help them acquire different resources to implement innovative farming systems such as conservation farming in pursuit of increasing agricultural productivity and enhancing food security.

#### **4.11.10 Access to agricultural services**

Study findings revealed that access to agricultural services has a role to play in determining the adoption of conservation farming. Respondents indicated that they require access to agricultural services that include access to information from agricultural extension officers, access to expertise advice, and access to opportunities for training from the Agricultural Extension Officers or partners in agriculture. Participants indicated that it is difficult to adopt a farming approach without support from those experienced or without the valuable knowledge on how the technology works. It is in this regard that access to agricultural services acts as a support base that smallholder farmers need to have as they decide on adopting a new technology. Smallholder farmers indicated that change in the way of doing things is accompanied by stress emanating from the fear of failure from

trying the new technology and this fear of failure is exacerbated by the already experienced challenge of food insecurity affecting the smallholder farmers. As such, access to agricultural support services helps farmers to move step by step as they try out the new technology of adopting conservation farming and hence this becomes critical in determining the adoption of conservation farming. It should be noted that smallholder farmers indicated that there are limited Agricultural Extension Officers to efficiently cover the whole District. The challenge of limited access to agricultural services is further worsened by the limited resources that affect the movement of Agricultural extension officers. Respondents revealed that the limited access to agricultural support services is one of the major challenges affecting the adoption of conservation farming. Agricultural Extension Officers explained that through an observation of farming areas, it can be noted that those smallholder farmers with farms located close to the main roads are the ones that are keen on implementing innovative farming systems and this is attributed to the consistent availability of agricultural support from the extension officers. The results are challenging the state and the private sector to invest in helping Agricultural extension agents' access resources that can better help them offer full support to the smallholder farmers.

#### **4.11.11 Socio cultural factors**

Results from the study are demonstrating that culture is assuming a tremendous role in determining whether or not smallholder farmers will make use of conservation farming. Through the focus group discussions, respondents revealed that culture decides if smallholder farmers will embrace the utilization of conservation farming. This is because there is a strong understanding by the community members that maize as the staple food in Zimbabwe is only planted in the official rainy season and the process of producing maize requires ploughing the land to maximise on eliminating weeds. This is a system of doing things that is in conflict with the principles of conservation farming. Majali (2016) argues that smallholder farmers live in a society where there is a standard of doing things. This is a standard that is acquired through experience and it becomes imbibed as a part of their life. Thus cultural factors become obstacles to the adoption of conservation farming. The smallholder farmers learn to appreciate that the only way to produce maize is through first tilling the land contrary to the principles of conservation farming. Hence their strongly held beliefs

and attitudes may take time to change. This then poses as a serious constraint to the adoption and full utilization of conservation farming by smallholder farmers.

#### **4.11.12 Age**

Sixty percent (60%) of the respondents agreed that age is key in determining the adoption of conservation farming. Agricultural Extension Officers indicated that age plays a role in influencing smallholder farmers on whether they will accept being trained and also accept the technologies introduced to them. Consequently, this explains why the older farmers in the study constituted the majority in terms of the farmers making use of the conventional method of farming. Results from the focus group discussions demonstrate that age assumes a vital job in deciding if one will make use of conservation farming or not. The respondents in the focus group discussions demonstrated that conservation farming is a strategy that requires diligent work and very much bodied individuals and therefore can be successfully done by the individuals who are youthful. This finding reflects an important phenomenon of investing in human capital with a particular focus on the youth. Agricultural Extension Officers explained that the youth are often left out when it comes to the redistribution of land. It is in this regard that when the youth are seen to be active in farms they are mostly doing it in support of their elderly family members who directly own the farms. Through the focus group discussions respondents however noted that the youth are in most cases not mature enough to manage smallholder farms on their own. This stereotyped view by the respondents presents a major challenge affecting developing countries where the youth are not being given a seat on the table. It is critical for the government and the community to awaken and realise the important role that the youth can play in scaling innovative agricultural systems such as conservation farming. Hence it is paramount to invest in the skills and training of the youth considering the role that age plays as the youth are the future leaders in growing the agriculture base for developing countries.

#### **4.11.13 Land tenure**

Weak property rights were noted as a factor that is affecting the adoption of conservation farming. Through the focus group discussions it emerged that weak land tenure rights made it difficult for

farmers to commit resources for practicing conservation farming as they could be evicted from their farms at any time as has been the case where those with political power have been seen displacing smallholder farmers from their allocated land. The weak property rights and the decision by the smallholder farmers not to fully commit to investing in agriculture through the use of conservation farming is a reflection of the absence of trust between the farmers and the state. The new institutional economics theory explains that institutions such as property rights have a role to play in affecting the adoption of an innovation. The study has revealed that property rights accorded to the smallholder farmers are constraining the adoption and effectiveness of conservation farming through deterring the full commitment from the farmers on investing in their farms. Respondents revealed that it is surprising that the government that was elected in 2018 has made significant strides in according former commercial white farmers with 99 year leases that guarantee security of tenure. The respondents added that the stance that the government has taken in according former commercial white farmers with 99 year leases without making an effort to secure the tenure rights of black farmers will be viewed as process of undermining the gains that were made of empowering the black majority through the fast track land reform programme. The results from the study suggest that secure tenure rights are an important determinant for the adoption conservation farming as it gives the smallholder farmers the autonomy to invest in farms without fear of being evicted and also provides the platform for smallholder farmers to have collateral which is vital in accessing financial capital.

#### **4.11.14 Access to credit**

Respondents indicated that the aspect of failing to access loans from the banks is a challenge that is rooted from the weak tenure system where smallholder farmers were given offer letters as proof of landownership. However banks are rejecting offer letters as collateral and hence smallholder farmers fail to get access to loans and as a result have no support mechanism to scale agricultural productivity. Participants in the focus group discussions indicated that they do not have access to loans because of the nature of their offer letters that cannot be used as collateral in banks. Gonese et al. (2017) argue that smallholder farmers are faced with a challenge of not being able to access long term loans for implements and other developments due to lack of collateral.

It should, however, be noted that three percent of the participants who indicated that they have access to loans are part of a group that was established through the influence of a local financial institution, Steward Bank. The smallholder farmers indicated that the bank is availing opportunities for them to access loans that will aid as a base in helping them access critical inputs to support their farming activities and ultimately enhance their livelihoods. The respondents further indicated that the bank seeks to improve financial literacy among smallholder farmers and enhance their access to financial inclusion. Respondents have, however, indicated that there is resistance among smallholder farmers in terms of being part of a group and this resistance emanates from stereotypes and superstitious beliefs emanating from mistrust among smallholder farmers.

#### **4.12 Conclusion**

In this chapter the researcher presented the findings of the study. This was done through the use of the students' T tests, the repeated measures analysis of variance, cross tabulations and narratives from the focus group discussions and the key informant interviews analyzed through the use of thematic analysis and nvivo. A deliberate focus in this chapter was to present data on the nature of conservation farming practiced in Zimbabwe and the potential benefits of using conservation farming as perceived by the smallholder farmers. A comparison between the agricultural output for smallholder farmers using conservation farming and those using the conventional method of farming was done as part of the natural experiment to assess the effectiveness of conservation farming. The chapter also focused on presenting findings on the constraints of conservation farming which are related to the challenges that smallholder farmers face in making use of conservation farming. The determinants of conservation farming were also presented as they are key in establishing the solutions that can be implemented to enhance the effectiveness of conservation farming. The following chapter focuses on the implications of the findings in relation to policy. The conclusions of the study are also presented together with a prototype model of implementing conservation farming systems.





## **CHAPTER FIVE**

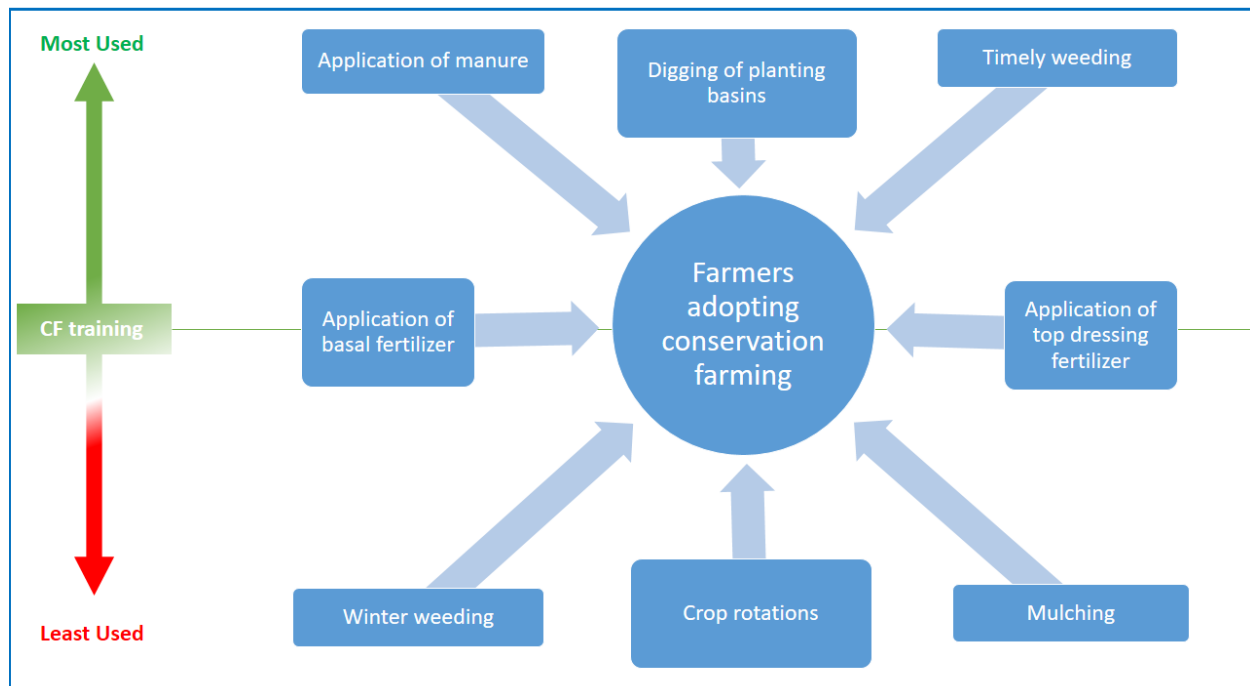
### **CONCLUSION**

#### **5.1 Introduction**

The study findings and analysis have revealed that the use of conservation farming is critical in improving agricultural productivity. However, it is important to note that the results from the study have highlighted challenges that come with the use of conservation farming and this requires the active engagement of the local community in providing sustainable solutions. The sustainable livelihoods approach has confirmed the importance of placing local community members at the centre of determining the sustainability of development interventions. This chapter concludes the research by discussing the objectives that were used to direct the study in relation to the research findings. The implications of the study are discussed as the research provides recommendations to enhance the effectiveness of conservation farming. The chapter also presents a conservation farming prototype model which will be vital in providing a starting point in the implementation of conservation farming systems with the ultimate idea of improving agricultural productivity. This prototype has been developed in collaboration with the participants of the study, recognizing their important role in the implementation of sustainable conservation farming systems.

## 5.2 Analysis

### 5.2.1 Nature of conservation farming implemented in Zimbabwe



**Figure 5.1: Flow chart outlining the nature of conservation farming practiced in Umguza District.**

Principles on the higher level of the flow chart that include the digging of planting basins with minimum tillage, timely weeding, basal fertilizer application and top dressing fertilizer application are the most widely used by smallholder farmers in Umguza District as presented in Figure 5.1. The principles of crop rotations, mulching and winter weeding are the lowest used principles. It should be noted that although crop rotations and mulching are the least used principles of conservation farming by smallholder farmers, they are the most important principles underpinning

the use of conservation farming. Conservation farming has three key principles that include minimum soil tillage, crop rotations and soil cover through the use of mulch. The other principles used by smallholder farmers in Umguza District that include early weeding, basal fertilizer application and top dressing fertilizer application stand as sub principles guiding conservation farming implementation that fall under the fourth broad category of the principles of conservation farming that are described by FAO (2018) as the good management principles.

The results from the study have shown that smallholder farmers have an understanding of the core principles that inform the use of conservation farming. The appreciation of the principles of conservation farming emanates from the training that smallholder farmers have received from different stakeholders working in agriculture. The study has also revealed that despite having an appreciation of the different principles of conservation farming, smallholder farmers are not making use of all the principles in their practice of conservation farming. This is because smallholder farmers are of the view that some of the principles of conservation farming cannot be universally applied to all areas. For instance, respondents indicated that crop rotations as a principle of conservation farming may not universally apply to all communities. The basis of this argument was that they only receive rains once a year during the rainy season and as such do not have any access to water that includes irrigation water. Secondly, it is difficult to rotate crops in one farming season since the majority of smallholder farmers rely on growing maize in each consecutive year as it is the staple food. As such, it becomes difficult for them to then plant crops all year round. In addition, results from the focus group discussions point out that some of the principles underpinning the use of conservation farming that include mulching are not highly practiced in Umguza District. This is because smallholder farmers in the area face a wide range of challenges that include failure to access inputs that include grass and stover. Through the study results it emerged that smallholder farmers are in need of a conservation farming model that is best customized to suit the unique needs of their environment. This is based on the results from the focus group discussions where respondents indicated that some of the principles of conservation farming cannot be universally applied as the needs and dynamics of each community are unique.

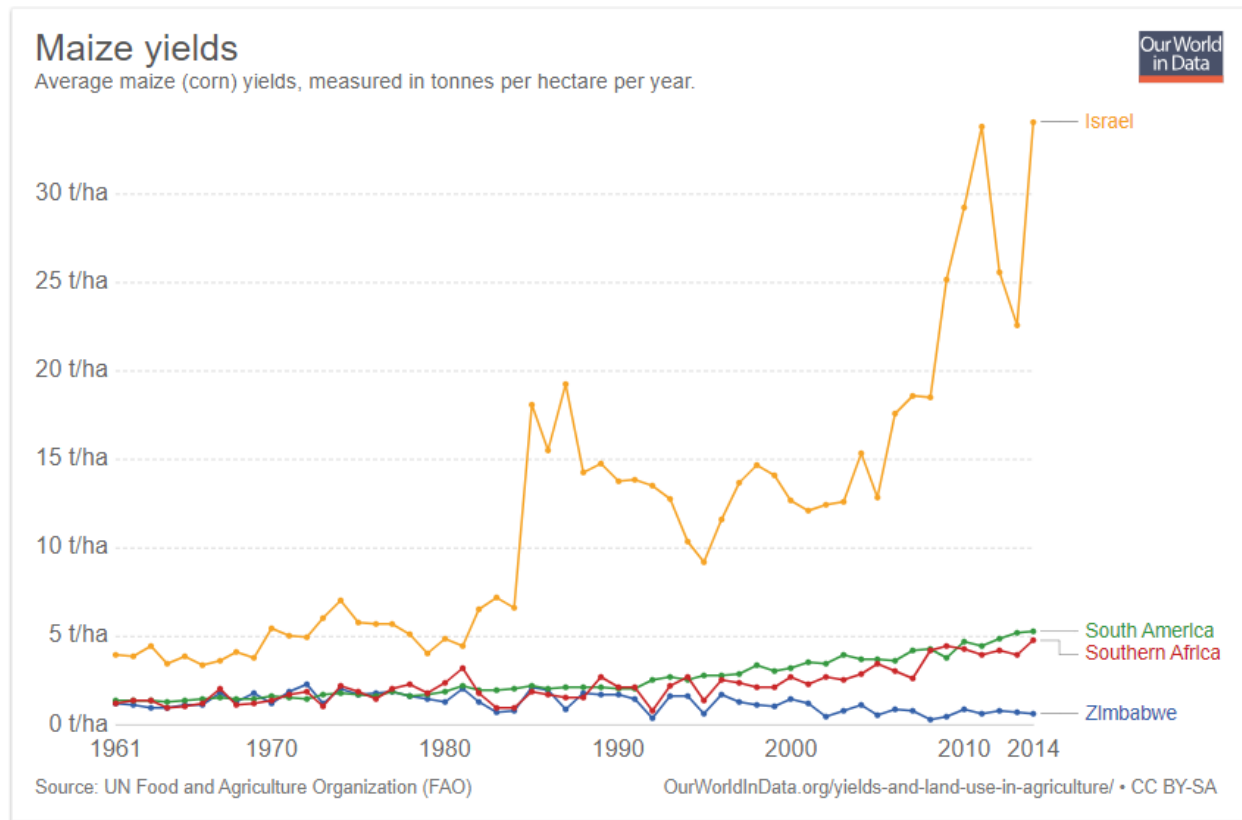
Su (2018) acknowledges that the sustainable livelihoods approach is a people centred school of thought that emphasizes the need to involve the community in development albeit with challenges. The sustainable livelihoods theory points out the need to involve the local community in any development initiative that is aimed at meeting the needs of the community hence being termed a people centred approach. The results from the study suggest that smallholder farmers were not included in the discussion to deliberate whether adoption of the suggested principles of conservation farming would be best suitable for their local context hence the introduction of conservation farming did not focus on the unique user needs of the smallholder farmers. Cummins and Coventry (2009) argue that, participation is an instrumental method in developing and implementing any farming culture and is one that should guide farmers as they develop their farming systems.

Bifulco (2008) argues that community participation is now being regarded as an inclusive technology necessitated by governance that seeks to empower citizens and emancipate them from the passive role of being mere targets of policies. The research established that 74% of the respondents explained that there is increasing competition for the utilization of mulch that includes grass and stover, as it is also utilized for thatching and stock feed. The implication is that smallholder farmers should have been involved in choosing and tailor making the principles of conservation farming to better meet their unique needs. This does not necessarily mean coming up with a new model of conservation farming but improving the already existing model in the process customizing it to suit the local environment.

### **5.2.2 Association between conservation farming and increase in agricultural productivity**

The study sought to establish the association between conservation farming and the increase in agricultural productivity through investigating if there are any differences in agricultural output per hectare between smallholder farmers using conservation farming and those using the conventional method of farming. Results from the statistical tests that were carried out have shown that there is a significant statistical difference in the output harvest per hectare reflected by the average p value of  $p < 0.01$  between farmers using conservation farming and those farmers using

the conventional method of farming. The significant statistical difference is an indicator that smallholder farmers adopting the use of conservation farming have been producing a higher output harvest than those smallholder farmers using the conventional method of farming. It should, however, be noted that although smallholder farmers making use of conservation farming are receiving higher yields than those using the conventional method of farming their output harvest is still below standard expectation, hence leaving the smallholder farmers susceptible to the realities of droughts as a result of climate change and variability. According FAO (2018), it is hoped that through the adoption of conservation farming, smallholder farmers in Zimbabwe are supposed to be able to harvest an average of two tons per hectare which is three times what their counterparts who are using the conventional method of farming will be able to produce. Results from the study are showing an average output harvest of 1 hectare to between 1 ton and 1.5 tons.



**Figure 5.2: Output yield per hectare analysis of Israel and Zimbabwe**

Source: Roser and Ritchie (2018)

Through Figure 5.2 above it can be noted that through the various technologies that Israel has implemented in its farming approach, agricultural productivity has increased with a hectare producing an average 30 tons of maize. The world's population is predicted to reach 10 billion in the year 2050. It is from this background that food production has to grow by 60% to provide for the expanding population as smallholder farmers are not in any position to increase the size of their land (GHI, 2018). It is necessary for smallholder farmers to become more effective and this can be done through the adoption and maximum utilization of new farming technologies. This becomes an instrumental challenge that Zimbabwe has in terms of ensuring that smallholder farmers use innovative technologies that include the adoption and maximum utilisation of conservation farming and are given the ability to multiply the amount of tons of maize that they get per hectare.

### **5.2.3 Challenges and opportunities related to the use of conservation farming**

Seratti (2018) posits that the sustainable livelihoods framework identified factors that enhance or constrain livelihoods and these include financial capital, human capital, social capital, physical capital, natural capital and human capital. Challenges affecting access to the various livelihood capitals are discussed in relation to the opportunities that exist in dealing with the challenges. The study has identified different challenges that are affecting smallholder farmers in the process affecting their full potential to increase agricultural productivity through the use of conservation farming. Results from the study show that smallholder farmers are affected by various challenges that include lack of access to inputs that can enhance their efficiency and effectiveness. The study has also shown that failure to access financial capital from banks is challenge that is affecting smallholder farmers from scaling their agricultural activities. Through the study, it emerged that the opportunity for the challenge related to access to inputs is for smallholder farmers to establish groups and be part of schemes such as that of the Steward bank livelihoods programme that seek to transform the livelihoods of smallholder farmers through giving them access to credit without requiring any form of collateral. As the study has shown, uptake of this programme by the bank has been low due to smallholder farmers resisting working in groups. Access to credit will be key in meeting the financial capital needs of the smallholder farmers that will in turn enable them to access inputs and resources instrumental towards helping them increase agricultural productivity.

Respondents also indicated that the use of conservation farming is labour intensive and this has been worsened by the increase in rural urban migration where family members move to the urban areas in search of greener pastures, in the process leaving smallholder farmers with limited labour to work on the fields. The labour challenge brings out the need for smallholder farmers to consider early preparation of land and planting. This will give the smallholder farmers the opportunity to prepare their land and plant their crops on time without the immense demand for labour. The study revealed that for this to be possible it is important for smallholder farmers to take their farming activities as a process and not an event. Working in groups will provide a platform for the smallholder farmers to share the burden for labour and in the process deal with the labour challenge. The opportunity of working in groups will also provide a platform for the smallholder



farmers to share experiences on what works or does not work in the implementation of conservation farming. This is critical in empowering smallholder farmers to deal with challenges as they encounter them.

Limited government support for the activities of smallholder farmers is another challenge affecting smallholder farmers. Respondents indicated that in the event that the government decides to support smallholder farmers, the assistance is usually associated with conditions that are politically inclined, hence exposing politicized state assistance to smallholder farmers. The challenges associated with limited government support and insecure tenure rights are tied to the lack of social capital among smallholder farmers in Umguza District. Setti (2018) explains that the sustainable livelihoods approach places an emphasis on social capital which has to do with the relations, networks and support that smallholder farmers get either from their peers or from the government based on trust. From the study, it is evident that social capital is lacking and as a result this constrains smallholder farmers from getting the support that they need to maximize on increasing agricultural productivity through the use of conservation farming. By taking a closer look at the miracle story of the success of South Korea with a particular focus on the importance of social capital in encouraging innovation among smallholder farmers, Han (2018) explains that South Korea harnessed on social capital through trusting villagers from the Korean rural Saemaul movement by providing them with grants despite political affiliation. This resulted in the villagers' sense of ownership being increased, as did the possibility of grass-roots innovation. The term grass-roots innovation in this sense meant the opportunity for villagers to actively choose their farming methods and crops by matching them with their own village circumstances. The government has a responsibility of ensuring food security in the country and of also implementing measures that will play a role in moving the country from being a low income country to becoming an upper middle income country. Part of the measures for making this a reality will entail working closely with the smallholder farmers considering the important role that agriculture plays in contributing to a nation's GDP. The quick win in this area is to depoliticise access to state support. This is a process that requires national healing to close the division of the Zimbabwean population based on political affiliation. National healing is important in helping smallholder farmers have faith and trust in their government in the process providing an enabling environment for a shared

vision and participation between the state and the smallholder farmers. The shared vision will in no doubt foster collaboration from the different partners in the development sector in coming up with lasting and mutually beneficial solutions vital in increasing agricultural productivity.

Limited appreciation of technology was also identified by the respondents as a critical challenge affecting smallholder farmers. The ability to appreciate and comprehend technology is hinged on the human capital of the smallholder farmers. Hence it is critical to build the human capital of the smallholder farmers with a particular focus of ensuring that they have a clear comprehension of the use of technology in their implementation of conservation farming. There is no doubt that agriculture has a role to play in scaling agricultural productivity bearing in mind the demands of the fourth industrial revolution that have an expectation for developing countries to harness on the use of technology to improve productivity. The World Bank (2018) posits that technology has an increasing role to play in dealing with the development challenge related to famine and as a result an artificial intelligence model to deal with the harsh effects of famine has been developed by leading technology hubs that include Microsoft, Amazon and Google. As such; smart phone applications have been developed that smallholder farmers can have access to. The applications are critical in helping smallholder farmers predict weather patterns, understand diseases and pests that are affecting their crops as well as provide a platform for smallholder farmers to interact and share their farming experiences. It is predicted that by the year 2025 an estimated eight billion people will have access to a smart phone either directly or indirectly (World Bank, 2018). Hence it is an opportunity to begin investing in the human capital skills of the smallholder farmers so as to ensure that they have a comprehensive understanding of the use of technology in order to enhance the effectiveness of conservation farming in increasing agricultural productivity.

#### **5.2.4 Factors that determine the adoption and maximum utilization of conservation farming**

The results from the study have identified different factors that determine the adoption and maximum utilisation of conservation farming and one of these is information dissemination. Results from the study have shown that limited information regarding the use of conservation

farming is playing a significant role in deterring the adoption and the maximum utilization of conservation farming. Forty five percent of the respondents cited limited information on the use of conservation farming as a constraint affecting smallholder farmers with respect to use of conservation farming with 39% of the respondents highlighting that they have not been adequately trained to make use of conservation farming, an indicator of an information gap on the use of conservation farming. Twomlow (2014), in explaining the diffusion innovation theory and the important role that information plays in the adoption of a technology, acknowledges that information that is shared by Agricultural Extension Officers is an important variable in the adoption of conservation farming. Sibanda et al. (2015) posit that the sustainable livelihoods theory places emphasis on human capital which denotes the important role that information plays in contributing to human capital which is a key determinant of sustainable livelihoods. It is against this background that information dissemination is a factor that plays a central role in determining the adoption and maximum utilisation of conservation farming. This brings out the need of an effective communication channel and continuous training on the effective use of conservation farming.

Results from the study have also shown that gender roles are part of the factors that determine the adoption and maximum utilisation of conservation farming. Through the focus group discussions, respondents indicated that the triple roles that women have and the aspect of the use of conservation farming being labour intensive has a bearing in affecting the adoption of conservation farming. As a result of customary gender roles, Niang et al. (2011) explain that there are differences in terms of equality of opportunities with respect to access to resources between men and women in Africa. These differences are evident when analysing access and utilisation of land natural capital), access to credit (financial capital), access to education, and access to extension services (human capital) with regard to the sustainable livelihoods theory. Gender equality opportunities in terms of access to the livelihood capitals is important in supporting transitions to conservation farming. It is in this regard that, when addressed, customary gender roles contribute to the factors that determine the adoption and maximum utilisation of conservation farming.

Through the results of the study, health and well-being emerged as a critical factor that determines the adoption and maximum utilisation of conservation farming. Sixty five percent (65%) of the respondents revealed that conservation farming is a highly labour intensive approach that inhibits smallholder farmers from making use of the farming approach. As such it becomes a challenge to make use of the approach due to its demands for labour. In addition respondents in the focus group discussion indicated that conservation farming is a method that requires hard work and well bodied individuals and thus can be effectively done by those who are young. The aspects that the smallholder farmers have highlighted are related to the health and wellbeing of the smallholder farmers. Respondents indicated that if the farmers are weak physically and are affected by poor health conditions this can constrain the full adoption and utilization of conservation farming. Human capital means three basic things and these include investment in basic health so that people have longevity, they are productive and they have the capacity to achieve their physiological potential. Second and related to that is nutrition which underscores the need for the community to have access to food security. This entails having a decent diet to be active and to be healthy. The third part of human capital is education. This entails developing brains so that smallholder farmers can access decent education, can gain literacy and problem solving skills and specific job market skills needed to attain a talented, skilled, flexible and dynamic work force (Sachs, 2018). The implication from the sustainable livelihoods theory is that health and wellbeing are critical elements of sustainable livelihoods and are seen to be playing a significant role as a factor that determines the adoption and the maximum utilisation of conservation farming.

The attitudes that smallholder farmers hold also emerged as a critical factor that determines the adoption and maximum utilisation of conservation farming. One hundred percent (100%) of the Agricultural Extension Officers revealed that the attitudes that smallholder farmers hold towards the use and the perceived success of conservation farming have a role to play in determining the adoption and full utilization of conservation farming. According to Orr (2003), Rodger's five stage model of the diffusion innovation theory outlines in its second stage of persuasion that an individual develops an attitude which may either be favourable or not towards the new innovation which is often influenced by the subjective opinions of their peers. It is against this background that the cultural beliefs influencing the behaviours of the smallholder farmers, together with their

perception that conservation farming is a labour intensive approach with minimum value addition, may act as a hump in affecting the adoption and full utilization of conservation farming. It should be noted that in the case of this study the opinions of other smallholder farmers played a minor role in influencing the attitude of smallholder farmers. This is because the results from the study show that the modal group of the smallholder farmers contributing 37% revealed that they do not have a network where they can share their farming experience with other farmers. This is an indication that the majority of the smallholder farmers' work in silos without a support system to share, learn and develop attitudes towards the use of conservation farming as a result of the influence from other farmers. The study, however, acknowledges that attitudes formed towards the use of conservation farming as a result of the influence from other smallholder farmers may be beneficial to the adoption of conservation farming in the event that the influenced attitudes are positive and also limiting in the event that the influencing attitudes are negative. By and large attitudes play a significant role as a factor that determines the adoption and full utilization of conservation farming among smallholder farmers.

Through the findings of the study, access to resources also emerged as a critical factor that determines the adoption and maximum utilization of conservation farming. Eighty percent (80%) of the respondents indicated that access to inputs was a major challenge affecting the adoption and maximum utilization of conservation farming. Through focus group discussions, respondents indicated that there is need for the government to assist smallholder farmers in getting access to inputs. Conservation farming has been subjected to attacks by critics who claim that the use of the hand hoe for digging planting basins is dehumanizing to the smallholder farmers and should be done away with (Masiyiwa, 2017). The solution to this challenge has been to mechanize conservation farming through the use of tractors attached with rippers to help in the digging of planting basins. However, the challenge that stands before the smallholder farmers is on where they will get those inputs as they are expensive. The sustainable livelihoods theory places emphasis on the financial capital which relates to the smallholder farmers' ability to access credit that will enable them to purchase farming inputs. It should be noted, however, that Agricultural Extension Officers revealed that they believe agriculture has evolved into agribusiness and as such smallholder farmers are not entirely obliged to purchase inputs that include machinery such as

tractors at individual level. The argument is that smallholder farmers should see an opportunity to innovate in the challenges that they are facing; that is to say, they should be able to harness their social capital to unite, buy inputs as a group and collaborate in sharing and using the machinery. This is directly related to the aspect of indigenous knowledge systems where smallholder farmers previously worked as a group to deal with the challenges related to limited access to inputs.

The aspect of socio cultural factors also emerged as a critical driver in determining the adoption and subsequent maximum utilisation of conservation farming by smallholder farmers. Sociocultural factors in this instance refer to stereotypical beliefs that smallholder farmers hold. Through the focus group discussions participants revealed that culture regulates whether smallholder farmers will adopt the use of conservation farming. This is so because of the strong belief system among the smallholder farmers that maize as the staple food in Zimbabwe is only grown during the rainy season and the process of growing maize involves tilling the land in a haphazard manner. Through this belief that smallholder farmers grow up to hold it becomes a challenge to have a shift in habits from the usual way of doing things. According to Morse and McNamara (2013), the sustainable livelihoods theory is founded on the principle that development interventions have to focus on the people understanding what is important to them, how they are unique and how their different cultures affect the way they comprehend and appreciate livelihoods. This clearly shows the important role that cultural factors play in determining the adoption and subsequent use of conservation farming in improving the livelihoods for smallholder farmers.

### **5.3 Conclusions**

Through the findings from the study, it is clear that the participation of smallholder farmers and their sustainable livelihoods is instrumental in enhancing the effectiveness of conservation farming. One of the objectives of the study was to examine the association between the adoption of conservation farming and increase in agricultural productivity. The study results have shown that conservation farming is an effective method of increasing agricultural productivity in contrast to the conventional method of farming as reflected by the various tests that have been carried out in the study hence a positive association between the adoption of conservation farming and

increase in agricultural productivity. It should be appreciated that although conservation farming is playing an important role in increasing agricultural productivity, the output harvest per hectare is still very low in comparison to what other countries that include Israel are producing per hectare.

Another critical objective of the study was to assess factors that determine the adoption and maximum utilization of conservation farming. It is in this regard that the study has shown that although the use of conservation farming is yielding results in terms of increasing agricultural productivity, there are numerous factors that hinder the adoption of conservation farming that include access to resources, gender roles, the role of culture, access to training and support services from agricultural extension officers. This brings about the need for a deliberate approach that develops a model of conservation farming taking into account the different factors that constrain and promote the adoption and maximum utilization of conservation farming among smallholder farmers.

The study also had an objective of identifying challenges and opportunities on the adoption of conservation farming in Zimbabwe as smallholder farmers pursue to use innovative technology to increase agricultural productivity and ultimately improve their livelihoods. It is against this background that although statistical tests have shown a significant statistical difference in the output harvest of maize per hectare for those smallholder farmers using conservation farming and those using the conventional method of farming there are instances where the differences are thin between the two groups of smallholder farmers as this is mainly as a result of the erratic rainfall experienced by communities on a year to year basis since the inception of conservation farming. As such, this has become a major constraint to smallholder farmers in their quest to adopt the use of conservation farming because of the slim differences though not statistically different in the study but playing an important role in determining the adoption of conservation farming. Climate change and variability is a reality that continues to affect smallholder farmers and thus needs to be dealt with in a holistic way that takes a deliberate and intentional climate change adaptation model in dealing with the challenges that are affecting farmers, in the process strengthening smallholder farmer resilience in dealing with the climate change shocks that are a danger to the sustainable livelihoods of smallholder farmers.

Based on the five capitals underpinning the sustainable livelihoods theory, human capital in the form of the demands for labour and skills among smallholder farmers to effectively use conservation farming emerged as a challenge affecting the adoption of conservation farming. There is a need for smallholder farmers to be continuously trained on the use of conservation farming and be involved in the design process as this is critical in building the skills capacity of smallholder farmers. In terms of dealing with the demands for labour, the opportunity for smallholder farmers is to dedicate more time into farming by ensuring that land preparation is done on time. In terms of financial capital, the main constraint for the farmers was to get access to credit for acquiring the necessary inputs needed for them to invest in conservation farming. The inability to access credit stems from the weak land tenure rights that cannot be used as collateral in banks for borrowing. The opportunity in that regard is for smallholder farmers to make use of credit facilities provided for by a local institution- Steward Bank - that follows the Bangladeshi Grameen Bank model of giving loans to smallholder farmers without requiring any collateral and understanding the need to improve the rural livelihoods of smallholder farmers. An assessment of social capital revealed that smallholder farmers are working in silos; this is a major challenge as they do not get the opportunity to learn from each other and unite in increasing yields for their communities. The opportunity in that area is for smallholder farmers to collaborate and work together through continuous knowledge sharing which is critical in enhancing sustainability in the farming approach adopted. The challenge associated with the natural capital was related to the intangible factors of the natural capital that have to do with the erratic rainfalls and dry weather conditions that are negatively affecting smallholder farmers. This is because despite being disciplined in following the principles of conservation farming, smallholder farmers indicated that their crops are subjected to immense stress that affects their survival in the process eliminating the benefits of using conservation farming. The opportunity related to human capital is tangible which has to do with the access to land that smallholder farmers have. The recommendation for smallholder farmers is to innovate and produce as much as they can through the use of conservation farming.

Furthermore, the study had an objective to analyse the nature of conservation farming used in Zimbabwe. The observation through the research was the necessity to understand the unique



context of each community's needs which has to be taken into account as the practice of conservation farming is being implemented in a community. This is so because the results from the study have shown that there are smallholder farmers who are not practicing all the principles of conservation farming. For instance, smallholder farmers indicated that it was difficult for them to commit to engaging in crop rotation as well as winter weeding. Smallholder farmers indicated that they were trained on how to use and apply the principles of conservation farming and as such have an understanding of the principles of conservation farming. However, despite their understanding of the principles of conservation farming, smallholder farmers are not applying all its principles. This then brings about the need of a model of conservation farming that is localized to the unique communities of smallholder farmers with the full participation of smallholder farmers in the design of the farming approach. Mkandawire (2001) posits that it is possible for Africa to borrow models globally; however, there is need to contextualize these to the realities of Africa and the local communities. Through the study, results have shown that smallholder farmers have a greater chance of adopting the use of conservation farming when they are to receive support in the form of inputs that include seeds, fertilizer and machinery. It should, however, be noted that although smallholder farmers feel there is need for them to be supported first in order to adopt a farming technology, they need to be empowered to identify opportunities in the challenges that they face. This is critical in reducing the dependency syndrome among smallholder farmers by empowering them to take charge in developing lasting and sustainable solutions to the challenges they face.

It is important to understand that regardless of the concerns associated with the conservation farming approach being labor intensive, Agricultural Extension Officers are confident that the use of conservation farming has significant benefits. The aspect of the approach being labor intensive is an opportunity for smallholder farmers to begin the preparation of their land in time before the farming season begins hence dealing with some of the human capital challenges related to limited draught power. The implication is that conservation farming should not be treated as an event but a process or lifestyle for the smallholder farmers and in that case can also be easily used by those groups considered to be vulnerable in the community.

In conclusion, the results from the study have shown that smallholder farmers are not practicing all the principles of conservation farming based on the premise that the use of conservation farming cannot be mainstreamed across all communities as the needs of various communities are unique and this need to be taken into account through the active involvement of smallholder farmers in the design of a conservation farming approach localized to the unique needs of each community. The study has also shown that there is a positive association between the adoption of conservation farming and the increase in agricultural productivity as has been shown by the differences in the output harvest per hectare for smallholder farmers using conservation farming and those using the conventional method of farming. Challenges and opportunities related to the use of conservation have also been identified with the key opportunity in that objective being the need for smallholder farmers to be able to identify opportunities in all the challenges affecting them. The factors related to influencing the adoption of conservation farming have also been identified with the key lesson in that regard being the need to identify all the factors with the active participation of the smallholder farmers.

#### **5.4 Implications of the findings**

It is critical for the government to actively engage the clients who are the smallholder farmers in taking a holistic approach in the design of an agricultural policy that serves as a sustainable model to increasing agricultural productivity. In pursuit of this, a prototype model has been developed in collaboration with the smallholder farmers. The prototype model developed in this study is a starting point in helping development partners understand the importance of actively involving the programme clients in the design and implementation of policies that are aimed at transforming their livelihoods. Chinsinga (2015) posits that the sustainable livelihoods theory believes that poverty reduction strategies and sustainable development approaches should aim to ensure maximum participation and empowerment of the different actors affecting and affected by development interventions. The involvement of the smallholder farmers will require effective capacity building on the part of the programme clients who are the smallholder farmers in terms

of them participating in the designing of their own innovative conservation farming approach that will be localised to their specific needs. This is key in promoting ownership on the part of the smallholder farmers which is important in reducing the dependency syndrome and in empowering smallholder farmers to take charge of the challenges that they may face in the implementation of conservation farming systems. The research underscores the importance of a community based approach in the development of policies aimed at increasing agricultural productivity for the programme clients.

It is the responsibility of the government to form a coalition with different partners in the development and implementation of a deliberate conservation farming policy through mobilising resources and providing expertise advice to assist smallholder farmers thrive in the implementation of conservation farming systems. The coalition with different partners should not just end at the development and implementation of the conservation farming policy but should go a step further to the design and implementation of a monitoring and evaluation system that will serve as a guideline in ensuring that the major activities, outputs, outcomes and impact are tracked by clearly defined indicators. The monitoring and evaluation system will be vital in helping the various partners track progress and take corrective action in helping smallholder farmers implement effective, efficient and sustainable conservation farming systems. It is also recommended that different partners that include the government departments which are implementing conservation farming be engaged in continuous monitoring and evaluation to ensure discipline in the implementation of agreed principles and follow through on efficiency and effectiveness of the conservation farming systems. This will motivate and empower smallholder farmers to fully adopt conservation farming and in turn play an instrumental role in improving agricultural productivity.

It is also critical to continue capacitating smallholder farmers on the principles underpinning the use of conservation farming and its monitoring and evaluation systems. To this end, the training of conservation farming systems should be a continuous process to ensure the effective implementation and utilisation of conservation farming systems. Agricultural Extension Officers and non-governmental organisation teams need to encourage smallholder farmers to implement conservation farming principles on time as this is vital in dealing with the labour intensive

challenges associated with the use of conservation farming. This will entail a shift in behaviour on the part of the smallholder farmers as they turn around to engage in the implementation of farming activities as a process and not an event. The implementation of conservation farming systems as a process demands that smallholder farmers take up farming activities as a lifestyle imbibed in their livelihood strategies. The full commitment of smallholder farmers to the implementation of conservation farming systems will be central in ensuring timely weeding and timely preparation of planting basins that will be instrumental in dealing with challenges associated with the demand for labour.

The implementation of a conservation farming policy requires full commitment from all the key stakeholders with a shared vision. Promoting a shared vision from the various partners can be scaled through encouraging smallholder farmers to work in groups guided by the experts in agriculture. This should be done harnessing on the traditional method of sharing labour. As the study has shown in cases where smallholder farmers have already established conservation farming groups, this has laid fertile ground for smallholder farmers to access information, share experiences more easily and share the demands for labour. This is a critical aspect of harnessing on social capital which is an important driver of influencing the decision of smallholder farmers to adopt the use of conservation farming hence propelling the scaling of the innovative use of conservation farming in Zimbabwe.

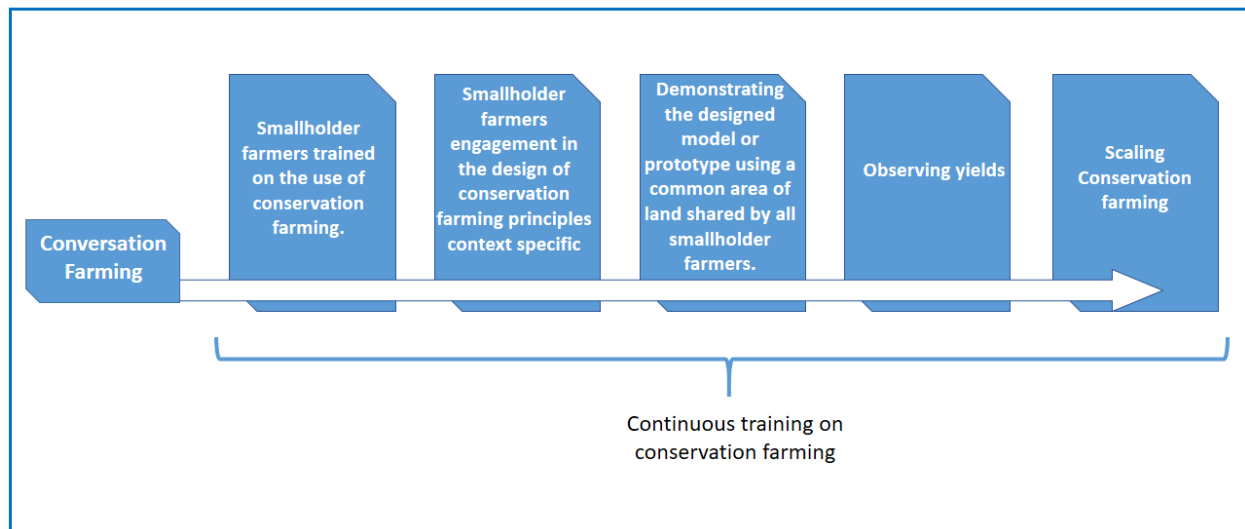
The need for ongoing research on innovative farming systems needs to be engraved in the nation's agricultural policy to ensure sure that there is a deliberate effort from all partners in the development discourse to work on establishing innovative technologies that will play a role in improving the effectiveness of conservation farming. The implication of this is that those experts involved in the development of good quality seed varieties that can thrive in dry conditions should be in a position to work with smallholder farmers taking into account the different social aspects that affect the agriculture sector in a holistic manner.

It is critical for development agents to collaborate in the strategic planning of the measures that can be taken to reduce the negative effects of climatic changes. Wagstaff and Harty (2015) note

that it is important that any discussion on food security recognizes that the intensity of drought as a result of climate change has significant impact on agriculture and food production. New technologies for irrigation schemes that include drip irrigation need to be encouraged to the smallholder farmers since the region is experiencing low rainfall. Government departments and partner organisations need to introduce development projects that focus on water conservation. This will increase the capacity of water availability and hence high chances of irrigation. There is also a need for ripper diggers to substitute hand hoes which are used by smallholder farmers for potholing, which is said to be laborious.

## **5.5 Prototype**

Based on the recommendations from the study, a prototype on the implementation of a conservation farming system in a community has been designed in collaboration with respondents as shown in Figure 5.3. The objective of the prototype is to enhance the effective implementation of conservation farming systems localised to the unique environment for smallholder farmers. It is hoped the prototype will be central in improving agricultural productivity through the use of conservation farming.



**Figure 5.3: Five stage model of implementing a conservation farming system**

### **5.5.1 Smallholder farmers training on the use of conservation farming**

The first stage in the implementation of a conservation farming system is to train farmers on conservation farming. This stage will entail defining what conservation farming is, explaining the principles of conservation farming and the benefits of using conservation farming. It is critical at this stage to give an overview of communities that have implemented conservation farming successfully. Inasmuch as the idea is to encourage farmers to adopt the use of conservation farming, it is important to enlighten them on the challenges that they may encounter as they make use of conservation farming.

### **5.5.2 Smallholder farmers' engagement in the design of conservation farming context specific principles**

Once smallholder farmers acquire an understanding of conservation farming, the next stage is to engage the smallholder farmers with conservation farming experts to design a conservation farming model localised to their unique context considering the three main principles of conservation farming that include crop rotations, digging of planting basins with minimum tillage and the use of mulch for permanent soil cover. This is the most important phase as the success of the model is largely based on this stage. Below are a few pointers to guide different stakeholders as they design a conservation farming model:

- (a) Smallholder farmers should be given the opportunity to decide whether crop rotations work for them. What is to be considered is whether they have access to water to sustain their crops all year round. Options to consider would be to drill a community borehole to ensure access to water all year round. If that option is not possible they could try making use of intercropping in one farming season so as to retain the benefits of crop rotations to the soil.
- (b) Timelines for the preparation of land that includes the digging of planting basins should be spelt out. This is important as each farmer understands their demands for labour. The possibility of sharing labour among the smallholder farmers should be highlighted and if agreed, the smallholder farmers can begin to make a schedule on how they are going to distribute their labour to the different smallholder farms.
- (c) It is important for smallholder farmers to brainstorm on how they will make use of mulch taking into consideration that there can be competition for mulch between the smallholder farmers and their livestock. Possibilities could be to make use of stover, make use of grass or designate specific areas for livestock feed. As the smallholder farmers decide on the implementation of these key principles of conservation farming, it is important for them to draw up the yield per hectare that they seek to attain, how they will do it and the challenges they may face as they do so. The identification of the challenges is vital in helping smallholder farmers deal with the problems as they face them. It is also critical for the smallholder farmers to identify and engage various organisations that can offer financial

assistance as they implement conservation farming. The engagement of the various organisations should be done through offering a unique value proposition that is beneficial to the organisations, the nation and the globe at large. It is also critical for the smallholder farmers to be assisted to assess how they can use technology to monitor their work and in the process decide on which form of technology they will use to scale their work. It is also vital to explain the importance of technology in helping the smallholder farmers meet their objectives in this digital age.

### **5.5.3 Demonstrating the designed model or prototype on a common area of land shared by all the smallholder farmers**

After the design of a conservation farming model localised to the unique needs of a community, it is important for the smallholder farmers to do a trial run of their developed model on a communally shared piece of land. The support of the traditional leadership is instrumental for this stage to be a success. The demonstrations should be done with the monitoring support given by the conservation farming experts. The process of monitoring what to record and track together with the indicators of success or failure should be clearly spelt out. A culture of recording should be encouraged to the smallholder farmers to ensure that they are in control of everything that happens on their farms. Through the demonstrations, lessons will emerge on what works or does not work in the proposed model and this gives the opportunity for the smallholder farmers to take corrective measures if there is need.

### **5.5.4 Observing yields**

The fourth stage is that of observing yields. This stage will involve taking note of the rate at which crops grow, the rate at which weeds need to be controlled and ultimately measurement on the size of land planted and the amount of crops produced. This stage is important as it has a role to play in motivating smallholder farmers to appreciate the adoption and use of conservation farming. For this stage to be rigorous, it is important for the smallholder farmers to have a control group to monitor the development of the yields under conservation farming and those under the traditional



method of farming. This comparison is vital in helping smallholder farmers appreciate the value of using conservation farming.

#### **5.5.5 Scaling conservation farming**

The final stage is that of scaling the use of conservation farming based on the developed model. The scaling of the approach requires continuous training of the smallholder farmers. There is need for a robust feedback system or platform that will enable smallholder farmers to continuously share their farming experiences and get information related to farming. The information channel could be through establishing a communal drop in center where the farmers can meet on agreed dates as well as the use of technology through applications that smallholder farmers can make use of to meet online and share their experiences.

### **5.6 Conclusion**

The chapter focused on articulating the discussion of the findings with an intentional focus of their implication on policy. The study concludes that there is a positive association between the use of conservation farming and the increase in agricultural productivity. The results from the study have shown that smallholder farmers are not implementing all the principles underpinning the use of conservation farming. This is due to the understanding that communities are different and hence the principles may not be universally applicable. Challenges related to the capitals underpinning the sustainable livelihoods approach have been highlighted as having an effect in affecting agricultural productivity. It is critical for the government and development partners to collaborate with the local community members in designing interventions that meet the needs of all stakeholders. This is paramount in the deliberate development of a policy that is owned by all stakeholders which is instrumental in the growth and maintenance of sustainable innovative farming systems. A prototype model of implementing conservation farming has been developed and this prototype is vital as a starting point for stakeholders to deliberate as they implement conservation farming systems appreciating the unique backgrounds of the programme clients.

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## APPENDICES

### **University of South Africa**

#### **Appendix 1 English Questionnaire**

University of South Africa

Faculty of Human Sciences

Department of Development Studies

Dear Respondent

I am a student pursuing a Doctor of Philosophy Degree from the University of South Africa. As part of my studies, I am conducting a research on the effects of conservation farming in Zimbabwe. The research is important as it seeks to find sustainable solutions of increasing agricultural productivity in Zimbabwe. Information obtained through this questionnaire will be used for academic purposes and will be treated with utmost confidentiality. Please do not write your name on any of the pages.

Kindly spare your valuable time and respond to the questionnaire as honestly and objectively as you can. Please respond to all questions. Thank you for your corporation.

Yours sincerely

Raymond Chipfakacha

**Instructions :** This questionnaire comprises two (2) parts. **Part 1** looks at your personal details whilst **Part 2** deals with your farming experiences.

PART 1: Personal details				
Age				
Sex				
Highest educational qualification				
No of years as a farmer				
Ward no:				
Province:			District:	
PART 2: Give answers by writing on the spaces provided or ticking in the appropriate box				
(1) Rate your agricultural productivity in the previous year	Excellent	Good	Average	Below Average
2.Type of farming method practiced	Conservation farming		Conventional farming	
3. Do you have any understanding of conservation farming with regards to farming systems?				
3b. If yes explain				

4. What have been the potential benefits of adopting your farming method?				
5. What have been the constraints in the type of farming method adopted?				
6. Is conservation farming suitable for communal farmers in this particular ward	<b>Yes</b>	<b>No</b>	<b>Partly</b>	<b>Not sure</b>
b. Give reason				
7. What can be done to enhance the effectiveness of conservation farming?				

Respond by ticking on the appropriate box

	<b>Agree</b>	<b>Strongly agree</b>	<b>Neutral</b>	<b>Disagree</b>	<b>Strongly disagree</b>
8. I have the necessary training to practice conservation farming					
9. I am aware of the different technologies that can be used to scale up agricultural productivity in my area					
11. I have the necessary financial resources needed to be a successful farmer.					
12. I have the labour to assist me in the farm					
13. I have a conducive climate (adequate water, fertile soil and favorable weather temperatures) for agricultural productivity					
14. I have a network where I can share my experiences with other farmers					
15. I have secure land tenure rights					
16. I receive assistance from the government.					
17. I understand the principles of conservation farming					
18. I understand the importance of using conservation farming					

19. I am not sure whether conservation farming is an effective farming approach					
20. I am satisfied with practicing conservation farming.					
21. I was not coerced into practicing conservation farming					
22. I can afford the cost of hiring and maintaining farm labourers					
23. I can easily access loans from the bank					

24. Respond by filling in the empty boxes below (NB: Measurements should be in hectares for area of land planted and tons for output harvested)

<b>2014</b>		<b>2015</b>		<b>2016</b>		<b>2017</b>	
Area of land planted	Output harvested	Area of land planted	Output harvested	Area of land planted	Output harvested	Area of land planted	Output harvested

25. Indicate the state of agricultural productivity in your farm over the past 4 years.

<b>Very good</b>	<b>Good</b>	<b>Average</b>	<b>Poor</b>	<b>Very poor</b>

26. Do cultural factors affect agricultural productivity in your area?

Yes	No

b. If yes explain.

27. Were you actively involved in determining the choice of your farming approach?

Yes	No

28. In your opinion is the assistance that you get from the government sufficient?

Yes	No

b. Explain your answer?

29. Do know of any technology that can be used to scale up agricultural productivity in your area?

Yes	No

b. if yes explain

30. Do you have adequate information on the use of conservation farming?

Yes	No

31. Do you think there are other farming approaches that are better than conservation farming?

Yes	No

b. if yes explain?

32. Do you think there are any benefits of using conservation farming?

Yes	No

b explain your answer

33. Do you know of any farmers with an increased agricultural productivity practicing conservation farming?

Yes	No

34. Are there any organizations in your area offering any form of support in farming?

Yes	No

b. If yes what kind of support are they offering?



*Thank you very much for taking your time for this study.*

## **University of South Africa**

### **Appendix 2 IsiNdebele Questionnaire**

University of South Africa

Faculty of Human Sciences

Department of Development Studies

Kuwe ophendulayo

Ngingumfundi oweUniversity of South Africa ngifundela iDoctor of Philosphy esigabeni seDevelopment studies. Kukhangelelwe ekufundeni kwami ukuba ngilobe ugwalo. kungakho ngibhala ugwalo ngidingisisa impumela yokusebenzisa ugantshompi elizweni laseZimbabwe ngemva kokwabiwa komhlabathi ngomnyaka ka2000 sikhangelwa eMguza. Ulwazi esizaluthola kuleli phepha lombuzo luzasetshenziswa endabeni zokufunda njalo luzalondolozwa njengemfihlo. Ngiyacela ungabhali igama lakho kuleli iphepha.

Ngiyacela isikhathi sakho esiqakathekileyo ukuba uphendule imbuzo elandelayo ngokuthembeka lobuqhotho. Ngiyacela ukuba uphendule yonke imbuzo. Ngiyabonga ngokuzwisisa.

Yimi engizithobileyo

uRaymond Chipfakacha

**Isixwayiso** : leli phepha liyehlukaniswe ngezigaba ezimbili. Isigaba **sokuqala** sikhangela imbuzo ephathelane lempilo yakho. Isigaba **sesibili** sikhangela ngezinto osuhlangene lazo njengomlimisi.

<b>Isigaba sokuqala: Okuphathelane lempilo yakho</b>				
Iminyaka yakho				
Ubulili				
Isifundo esiphezulu olaso				
Uleminyaka emingaki ungumlimisi				
Uhlala kuyiphi iward:				
Province:		District:		
<b>PART 2: Phendula imbuzo ngokubhala kumbe ukufaka ukwetshu esikhaleni esiqondileyo ngaphansi</b>				
(1) Tshengisa impumela yezilimo zakho	Kuyancomeka	Kuhle	Yikho nje	Kubi
2. Indlela yokulima esetshenziswayo?	Uganstshompi	Ukulima okujwayelekileyo		
3. Ungaba lolwazi lokusebenzisa ugantshompi njengendlela yokulima?				
3b. Nxa ulalo chasisa				
4. Yikuyini okuhle osukutholile ngokusebenzisa indlela yokulima oyisebenzisayo?				

5. Yibuphi ubunzima osuhlangane labo ngokusebenzisa indlela yakho yokulima?				
6. Ngokubona kwakho ugantshompi uyabafanela na abalimisi bakuleyi iward	<b>Ngiyavuma</b>	<b>Hatshi</b>	<b>Mhlawumbe</b>	<b>Angila qiniso</b>
b. Phana ingcazelo				
7. Ugantshompi angenziwa njani ukuba afanele abalimisi abakulindawo?				

Phendula ngokufaka ukhwetshu ebhokisini eliqondileyo

	Ngiyavuma	Ngiyavuma kakhulu	Yikho nje	Ngiyala	Ngiyala Kakhulu
8. Ngifundiswe okuzwayo ukuba ngisebenzise ugantshompi					
9. Ngilolwazi lwendlela eziphakemeyo ezingasetshenziswa ukungezelela izilimo esizitholayo.					
10. Ngilazo izinto ezikhaliphileyo ezidingekayo ukuba ngingezelelo izimilo esizitholayo kulindawo					
11. Ngilayo imali edingekayo ukuze ngibe ngumlimisi uphumelelayo.					
12. Ngilabo abasebenzi bokungincedisa emasimini					
13. Ngilendawo enhle egoqela amanzi aneleyo, inhlabathi enhle lomkhathi omuhle ukuze izilimo zingezelele.					
14. Ngilabo abantu abalimayo engixoxa labo ngokulima					
15. Ngilawo amaphepha akhombisa ngokwanele ukuba umhlabathi ngowami.					
16. Ngiyathola uncedo kuhulumende kwezokulima					

17. Ngiyazwisisa impawu zokusebenzisa ugantshompi.					
18. Ngiyazwisisa ukuqakatheka kokusebenzisa ugantshompi.					
19. Angilaqiniso lokuthi ugantshompi yindlela ebanzi yokulima					
20. Ngisuthesikile ngokusebenzisa ugantshompi.					
21. Angiphoqwanga ukuba ngisebenzise ugantshompi.					
22. Ngiyenelisa ukuqatsha lokubhadala izisebenzi zemasimini.					
23. Ngenelisa kuhle ukuthola uncendo lwemali ebhanga					

24. Phendula ngokubhala kumbe ukufaka ukhwetshu emabokisini aphantsi angelalutho (NB: Inombolo kazibe kumahectares)

2015		2016		2017		2018	
Indawo yonke elinyiweyo	Indawo evuniweyo	Indawo yonke elinyiweyo	Indawo evuniweyo	Indawo yonke elinyiweyo	Indawo evuniweyo	Indawo yonke elinyiweyo	Indawo evuniweyo

25. Tshengisa isimo sempumela yezilimo zakho eminyakeni emine edlulileyo

Kuhe kakhulu	Kuhle	Yikho nje	kubi	Kubi kakhulu

26. Ngokubona kwakho isiko liyaphmbanisa impumela yezilimo kulindawo?

Ngiyavuma	Hatshi

b. Nxa uvuma phana ingcazelo

27. Wawukhuthela na ekukhetheni indlela yokulima oyisebenzisayo?

Ngiyavuma	Hatshi

28. Ngokubona kwakho usizo oluthola kuhulumende lwanele na?

Ngiyavuma	Hatshi

b. Phana ingcazelo yependulo yakho?

29. Ungaba lolwazi lwendlela ezihlakaniphileyo ezingasetshenziswa ukungezelela impumela yezilimo ezitholwayo kulindawo?

Ngiyavuma	Hatshi

b. Nxa ulalo phana ingcazelo

30. Ungaba lolwazi olwanele lokusebenzisa ugantshompi?

Ngiyavuma	Hatshi

31. Ngokubona kwakho kulendlela ezingcono ezingasetshenziswa ukulima ezingcono kulokusebenzisa ugantshompi?

Ngiyavuma	Ngiyala

b. Nxa uvuma phana ingcazelo?

32. Ngokubona kwakho kukhona ubuhle obutholakala ngokusebenzisa ugantshompi?

Ngiyavuma	Hatshi

b Nxa uvuma phana ingcazelo

33. Kungabalabalimisi obaziyo abasebevune izilimo ezandileyo ngenxa yokusebenzisa ugantshompi?

Ngiyavuma	Hatshi

***Ngiyabonga kakhulu ngesikhathi sakho sokuphendula imibuzo.***



## **Appendix 3**

### **Focus group guide for the smallholder communal Farmers in Umguza District.**

Information gathered using the focus group discussion is intended to be used for academic purposes only. The Researcher is a Doctor of Philosophy student at the University of South Africa carrying out a research on the effects of conservation farming in Zimbabwe.

Respondents introduce themselves and give a background on their farming experience.

- (1) Describe the process of implementing conservation farming in your area
- (2) What are the determinants of adopting either the use of conservation farming or the use of the conventional method of farming?
- (3) Do you think conservation farming is an effective method of increasing agricultural productivity? Explain your answer.
- (4) What are the challenges that you are facing as smallholder farmers in adopting the use of conservation farming?
- (5) What role can technology play in strengthening the effectiveness of conservation farming?
- (6) Are there any recommendations that you think need to be implemented in order to enhancing the effectiveness of conservation farming?



## Appendix 4

### Interview guide for agriculture extension officers

#### Preamble

Information gathered using an interview is intended to be used for academic purposes only. The researcher is a Doctor of Philosophy student at the University of South Africa carrying out a study on the effects of conservation farming in Zimbabwe.

1. What is your understanding of conservation farming as practiced by the communal farmers in Umguza District?

2. What have been the potential benefits and challenges of adopting conservation farming?

3. What could be the possible solutions in tackling the challenges faced in the adoption of conservation farming?

4. Is there any difference in terms of agricultural productivity and food security among communal farmers who have adopted the use of conservation farming and those who are using the conventional farming method?

Yes ☐

No ☐

4b Explain your answer

5. Do you think conservation farming is suitable for Umguza District?

Yes ☐

Partly ☐

Not suitable ☐

Not sure ☐

5b Explain

6. Are you aware of any technology that can be used to promote the effectiveness of conservation farming?

Yes ☐

No ☐

b. if yes explain your answer

6. What can be done to enhance the effectiveness of conservation farming?

## Appendix 5 Reliability Tests

### Reliability Statistics

→ Cronbach's Alpha	N of Items
.924	2

### Item Statistics

	Mean	Std. Deviation	N
Question11a	3.90	1.101	10
Question11b	3.80	1.033	10

### Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Question11a	3.80	1.067	.860	.
Question11b	3.90	1.211	.860	.

### Scale Statistics

Mean	Variance	Std. Deviation	N of Items
7.70	4.233	2.058	2

### Intraclass Correlation Coefficient

	Intraclass Correlation <sup>b</sup>	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.859 <sup>a</sup>	.531	.963	13.138	9	9	.000
Average Measures	.924 <sup>c</sup>	.694	.981	13.138	9	9	.000

Two-way mixed effects model where people effects are random and measures effects are fixed.

**Reliability Statistics**

Cronbach's Alpha	N of Items
.899	2

**Item Statistics**

	Mean	Std. Deviation	N
Qustion14a	4.50	.527	10
Question14b	4.60	.516	10

**Item-Total Statistics**

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Qustion14a	4.60	.267	.816	.
Question14b	4.50	.278	.816	.

**Scale Statistics**

Mean	Variance	Std. Deviation	N of Items
9.10	.989	.994	2

**Intraclass Correlation Coefficient**

	Intraclass Correlation <sup>b</sup>	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.816 <sup>a</sup>	.421	.951	9.889	9	9	.001
Average Measures	.899 <sup>c</sup>	.593	.975	9.889	9	9	.001

Two-way mixed effects model where people effects are random and measures effects are fixed.

**Reliability Statistics**

Cronbach's Alpha	N of Items
.881	2

**Item Statistics**

	Mean	Std. Deviation	N
Question12a	2.00	1.414	10
Question12b	2.30	1.494	10

**Item-Total Statistics**

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Question12a	2.30	2.233	.789	.
Question12b	2.00	2.000	.789	.

**Scale Statistics**

Mean	Variance	Std. Deviation	N of Items
4.30	7.567	2.751	2

**Intraclass Correlation Coefficient**

	Intraclass Correlation <sup>b</sup>	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.787 <sup>a</sup>	.352	.943	8.407	9	9	.002
Average Measures	.881 <sup>c</sup>	.521	.970	8.407	9	9	.002

Two-way mixed effects model where people effects are random and measures effects are fixed.

*Correspondences should  
be addressed*

**Tel: 09-67261-3**

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**ZIMBABWE**

Ministry of Local Government,  
Public Works and National Housing  
Matabeleland North Provincial Office  
P O Box 1496  
Bulawayo  
6<sup>th</sup> Floor, Block G  
Mhlahlandlela Government Complex  
10<sup>th</sup> Avenue & Bach Street

**10 September 2018**

**District Administrators  
UMGUZA**

**RE: RESEARCH BY RAYMOND CHIPFAKACHA :UNISA**

This letter serves to grant authority to the above named to do a research in your District on "Effects of Conservation Farming in Zimbabwe.A case of Umguza district ,Zimbabwe". He will be visiting wards 9 and 12 .the aim of the study is to explore climate change adaption measures used in the sustenance of rural livelihoods in Umguza District.

May you assist were possible

Your usual assistance is greatly appreciated

Yours faithfully

G. Roundi

**For: Provincial Administrator**  
**Matabeleland North**

